DOMESTIC HYGIENE FOR NURSES

F. J. SMITH, M.D.

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WITH SO MUCH OF CHEMISTRY AND PHYSICS AS ARE NECESSARY TO THE REASONABLE UNDERSTANDING THEREOF

BY

FRED. J. SMITH, M.D., F.R.C.P.

PHYSICIAN TO THE LONDON HOSPITAL
AND EXAMINER IN ELEMENTARY HYGIENE TO THE NURSING PROBATIONS

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PREFACE TO THE SECOND EDITION

I MUST apologise to my critics for having the audacity to publish a second edition of this little book in the face of their appeals to me not to do so. May I plead that as Hygiene is only one of half a dozen subjects of which our would-be nurses have to acquire some knowledge, in the short space of seven weeks, it is impossible to expect them to get more than an elementary notion of it in the time. So long, therefore, as there are no serious mis-statements in the book I do not think that even a critic can complain. Anyhow, I believe that those for whom it is intended find it useful, and there I am content to leave the matter.

FRED. J. SMITH.

HARLEY ST.;
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ELEMENTARY HYGIENE AND ITS ANCILLARY SCIENCES.

Hygiene is defined as the science of health, the term being derived from "Hygeia, the Goddess of Health." Health may apply either to an individual, when its rules and principles are spoken of as personal or domestic hygiene, or it may apply to a community, when the same rules and principles constitute public hygiene—a somewhat wider field than the well-being of an individual. Though the two, as a rule, run parallel, and are governed by the same laws of physiology, there are cases in which the health of the community may conflict with the comfort, if not with the health of the individual, as, for instance, the removal of a case of infectious disease from home to a fever hospital, or the cleansing and destruction of an old cesspool; the health of the community demands that the thing shall be done, though the health of the individual may suffer; nurses, too, in their professional capacity may not infrequently be called upon to risk their personal health for the sake

of a patient; this consideration alone should make her anxious to understand the principles which govern personal hygiene, though I think she may well leave most of the problems of public hygiene to medical officers of health and others whose special duty it is to study them.

Health demands that we should have air to breathe as pure as possible, water to drink as free from contamination as possible, food to eat in reasonable quantity and as wholesome as possible, clothing to wear reasonably adapted to circumstances of climate, occupation, etc., and houses to live in which will at least not interfere with any of these objects; personal health demands also a certain amount of exercise, recreation, and sleep.

Perhaps the first conscious question a child puts to nurse or mother is "Why?" To the infant mind the reply, "Because I say so," is enough, but as the child grows older this answer becomes less and less satisfactory. The human race is the child, and ever on its lips is the question "Why?" and by the endeavours of individuals to find an answer, each one carrying the matter a step further back, has all our knowledge grown, and now we think as a race that we are beginning to dimly perceive some of the laws of Nature—not of human nature, by the way.

Apply this to nurses learning or trying to learn the elements of hygiene; ever on their lips should be the question "Why?" and though for many the answer, "The text-book says so," will be enough,

at any rate in the earlier stages of their career, I believe that a few in the later stages of their training would like to go a little deeper, and I am sure that a little elementary knowledge of the laws of heat, of light, of chemistry, would clothe the dry bones of hygiene with the flesh of interest, and make lectures and reading more of a pleasure and less of a burden to them all, and the purpose of this little work is to try thus to make hygiene interesting by showing how its laws are based on the much wider ones of physics, chemistry, and physiology.

If one can do this, not only may a direct purpose of examination-passing be served, but by learning the laws and principles of her subject a nurse may now and again be helped to provide a second-rate substitute for a perfect article which is beyond her reach, and thus put her hygienic knowledge to a very practical use.

To suit those who do, and those who do not care about "why," two types are used throughout this little book: the larger type should be read by all, the smaller may be left to the choice of the reader.

CHEMISTRY AND THE NATURE OF MATTER, SUBSTANCE, OR MATERIAL.

ATOMS.

It is impossible to get from reading books a rational idea of "Why" without some knowledge—I will not say of chemistry, for that is hardly necessary, but of the phraseology of chemistry and the meaning in simple language of some terms used in it.

Now at the very threshold of the subject there is for the beginner just one primary stumbling-block or difficult scientific conception, and that is a mental picture of atoms; it is on the behaviour of these units of matter that practically all our physical and chemical laws ultimately depend. I will try and explain the word and the idea underlying it as briefly and as simply as possible.

Let us take a grain of charcoal or carbon (as it is scientifically called). Let us then keep on cutting our grain up into smaller fragments until we can no longer do so because any one fragment is too small to let us cut or grind it; the fragment is still visible under a lens or microscope. Now conceive the same process of division to be continued very, very far beyond the

reach of the highest powers of the very best microscope. After many millions of these divisions we ultimately arrive at what is known as an **atom** of carbon (the word "atom" literally means uncuttable or indivisible). To illustrate the almost inconceivable minuteness of the atom, it has been calculated that if the finest visible piece of charcoal were magnified till it was the size of the world, the atoms would then be about the size of cricket balls, or smaller.

In this illustration, to avoid complications, we have chosen an element carbon, had we taken a grain of a compound (say sugar or salt) we should ultimately have arrived at a **molecule**, so that we may say a molecule is to a definite chemical compound what an atom is to an element.

Chemistry deals with these same atoms and molecules in all their various combinations when brought into contact with one another ; it deals with their behaviour in combination and with the laws regulating these combinations. It tells us the composition and decomposition of the food we eat, of the purity or impurity of the air we breathe, and of the water we drink, and hence some little knowledge of it is essential to the understanding of hygiene, for without it chemical statements in works on hygiene are mere gibberish (the composition of air or the means for softening water for instance), but all the same the amount that a nurse need know is very small.

I will now define an element and a few other chemical terms which are required to make clear the idea of matter, of which the world and everything in and on it is made.

Definition 1.—An **element** is a substance out of, or from which, by no chemical or physical, or, indeed, by no means whatever known to us at present, can we extract anything but the same substance.

Of these elements there have actually been discovered sixty or more, but it is only with some ten or a dozen that a nurse need bother herself, and even as to these she wants little more than the names, so that a simple chemical formula need not, to her, be Chinese for all she knows.

The following with the brief notes are about all that is necessary, viz.

	Symbol.	Nature.	
Aluminium	Al	Solid	Metal.
Calcium	Ca	,,	,,
Carbon	C	,,	Non-metal.
Chlorine	Cl	Gas	,,
Hydrogen	H	,,	Metal.
Iodine	I	Solid	Non-metal.
Iron	Fe	,,	Metal.
Lead	Pb	,,	,,
Magnesium	Mg	,,	,,
Nitrogen	N	Gas	Non-metal.
Oxygen	O	,,	,,
Phosphorus	P	Solid	,,
Potassium	K	,,	Metal.
Silicon	Si	,,	,,
Sodium	Na	,,	,,
Sulphur	S	,,	Non-metal.

The symbol is the shorthand method, one might say, of writing down the element in chemical formulæ (*vide* below, p. 13). It usually consists of the first or first two letters of the name of the element in English or Latin.

Aluminium (Al): A metal admirably adapted for the manufacture of kitchen utensils, plates, cups, etc., and as it is now becoming very cheap it is being more and more used for many purposes as a substitute for earthenware and glass where breakages are an important consideration in the household.

Calcium, or lime (Ca): Is only of interest in that its salts form chalk, limestone, etc., which are practically pure salts of lime, and though these are very slightly soluble in water they actually are thus slightly soluble, and when so dissolved constitute the main element of what is known as the hardness of water, and there is a difference in this hardness according to whether the carbonate or the sulphate of lime is causing it. This difference can only be explained by chemical formulæ, but in ordinary language the former causes temporary, the latter permanent hardness.

Lime salts are a nurse's typical "mineral matter" in water. In combination with phosphoric acid Ca forms phosphate of

lime $Ca_3(PO_3)_2$, which constitutes the chief bulk of bone. Hence we require a fair quantity of Ca in our food and water.

Carbon (C) is undoubtedly next to radium, or perhaps even in greater degree that radium, the most fascinating element in the world; charcoal, the lead of a lead pencil. and the gem known as a diamond, are all forms of (nearly) pure carbon; libraries have been written on what it will do when combined with H. N. and O. in varying proportions and in various ways. Into this world of wonders there is, however, no time for a nurse to peep; suffice it for her to know that these four elements, but especially carbon, form very nearly the whole organic world, or, to put it another way, there are precious few organic materials, from boot leather up to a piece of meat, that do not contain carbon; hence it is pre-eminently *the* organic element in Nature.

All a nurse need know about it is, however, the very prosaic fact that whenever any organic material burns, CO_2 or carbonic acid is the principal product formed, often associated with the more poisonous CO or carbon monoxide. As to which product is formed, a good deal depends upon the heat at which the body is being burnt and the supply of oxygen which is provided for the burning. Coal-gas and the fumes from stoves burning coke contain a large proportion of CO, and it is this gas which constitutes the danger from these two sources; the avoidance of the danger lies in seeing that coal-gas is not escaping into a room, and that stoves are provided with non-leaking flues to convey the fumes *outside* the room; an antidote when an accident has happened is to carry the patient at once into the open air. It is interesting, but not of much importance, to a nurse to know that these gases form the after-damp in a coal-mine explosion.

Similarly she must know that CO_2 is contained in large quantities in expired air (*vide* "Respiration"). It may interest her to know also that it forms the sparkle of sparkling wines, and of the less attractive Soda, Salutaris, or Apollinaris water, and that quantities can be taken into the stomach which might be deleterious if admitted to the lungs.

Chlorine (Cl): The only interest this has for a nurse is that in combination with sodium it forms common table salt, NaCl,

and in combination with H it forms hydrochloric acid, which is the acid formed in the stomach to help us digest. By itself it is a yellow gas with a nasty smell, often enough perceived where bleaching powder is being made or used.

Hydrogen appears as a gas (though it is really a metal) ; it is one of the lightest bodies known to science, and therefore is used as a standard with which to measure or compare the weights of gases (*vide* specific gravity, p. 165). When chemically combined with oxygen in the proportion of two volumes or atoms of H to one of oxygen it forms water, H_2O, and when combined in equal volumes or atoms it forms HO or hydroxyl, or hyd. perox., the basis of a very favourite application to septic wounds, and therefore should be familiar to nurses. The only other point that a nurse need know about hydrogen is that it forms one of the essential parts of the ordinary acids which are used in testing urine, etc. (*vide* p. 15).

Iodine (I) is of medical interest as being found in the thyroid gland ; it is the active constituent in KI, potassium iodide, many tons of which are used annually as a medicine. It is found in minute traces in sea air and in large quantities in sea-weed and sea water.

Iron (Fe) is of intense hygienic and physiological interest, owing to the fact that a certain small quantity seems to be the very kernel of the life-history and physiology of the blood's red corpuscles. Also it is found in the shape of salts of iron as a constituent of water coming from many springs, and helps with lime salts in causing what is termed "hardness" (permanent) of water.

It is the basis of many so-called tonic medicines with which a nurse will become familiar in her work.

Lead (Pb) : A blue metal well known to everyone, the only physiological interest of which lies in the fact that it is used in enormous quantities for the making of water-pipes and other industrial purposes ; it is liable to oxidation in the air, and is, either in this state, or in the shape of some other salt, or perhaps even as the pure metal, slightly soluble in water, and the purer the water the more lead will it dissolve. Now lead, in the minutest discoverable traces (there is no limit like $\frac{1}{13}$ gr.

per gallon as is usually taught) in water is dangerous, and the water containing it should not be drunk habitually. In the matter of public, as opposed to personal hygiene, it is one of the most important problems to endeavour to prevent the entrance of lead into the system of men whose occupation brings them in contact with lead (mainly makers of pottery, of paints, etc.). The glaze on pottery used to be produced entirely by means of lead-salts, but leadless glazes have now been discovered and are being used.

Magnesium (Mg): Of no interest except as the basis of the familiar purgative salt, magnesium sulphate, and also of huge rocks of magnesium limestone, etc.; its salts are part of the hardness of water.

Nitrogen (N): A gas of no interest much to the nurse except in the fact that it is an indifferent gas, that is, it can be breathed comfortably enough, though of no use when so breathed so far as we know; it exists to the extent of nearly 80 per cent. in the air, acting there as a mere diluent precisely in the same way as water is used to dilute whisky for drinking, *i. e.*, if we habitually breathed pure oxygen we should very likely die pretty rapidly from excessive oxidation, just as we should soon get very drunk if we drank as much neat whisky as whisky and water. On the other hand, N is of the most extreme importance and value to plant life, but to show how this happens would carry us too far out of hygienic regions. The N contained in human tissues appears in the urine as urea and ammonia compounds when the body has no further need for its services.

Laughing gas, used by surgeons and dentists for short operations, is an oxide of nitrogen (a use for the term "gas" which the nurse will soon appreciate in the wards). It is the essential element of nitric and nitrous acids; millions of tons of it are required for the growth of animals and vegetables, and reach the tissues in the form of nitrites and nitrates (a combination of a base with nitrous and nitric acids).

Oxygen (O): A gaseous element, the very staff of life from the point of view of the chemistry of the body. The useful constituent of the air we breathe; without it we should be dead in a very few minutes. Although a gas, it has the power of very

easily combining with metals, and, indeed, all other bodies; familiar examples of this combination under simple exposure to air are the rust of iron when exposed to the air, the blackening of silver and the tarnishing of other metals under the same circumstances; in each case an oxide of the metal is formed. The means of preventing this rust and tarnish by wiping objects with spirit, or oil, or by keeping them quite dry, belongs to domestic hygiene. Two other aspects of this same oxidation come under a nurse's notice in her studies in hygiene, and help her to understand some simple phenomena.

One is the fact that whenever oxygen combines with an organic body heat is set free, or, as she would assert, produced. This statement must be accepted as a fact, for its explanation would lead us too deep into chemistry, but the illustrations of the law are some of the commonest phenomena of hygiene and physiology. Thus, a candle, a lamp, coal-gas and a fire are all cases in which oxygen is combining very energetically with the material mentioned. We call this burning, or catching fire; in reality it is oxidation, and the heat which we feel from these sources is the heat given off by rapid and energetic oxidation of oil, gas, or coal respectively; the things that are produced by this oxidation are chiefly CO, CO_2, H_2O, and other more complex things, when for some reason the oxidation is less energetic (*vide* under "Heat"). Precisely this same oxidation is going on in our body, and is indeed the main, if not the only, source of body heat, and two of the products of it in the body are identical with those produced in a fire, viz., CO_2 and H_2O, both of which are continually escaping by skin, lungs, and urine (*vide* under "Perspiration," p. 100).

To bring home to a nurse's mind the enormous amount of heat thus generated in the body that has to be got rid of we may state as a fact that it would each twelve hours more than suffice to actually boil her blood; thus we see that she has no need of an insult or other unpleasant incident to "make her blood boil" —her own heat would do it if it had the chance. The curious may follow the calculation necessary to arrive at the above conclusion; it is as follows:

One Calorie is the heat required to raise 1 lb. of water through

4° F. A man at rest weighing about 12 st. (which may be taken to represent a nurse at work of, say, about 9 st.) requires for health to take in his food the equivalent of about 2400 Calories. Say the food is only three-quarters oxidised, this then lets free 1800 Calories of energy; one sixth of this goes out as work, leaving 1500 as heat. Now, if 1 Calorie will heat 1 lb. 4° F. obviously 1500 will heat 1 lb. 6000° F., or 14 lb., 428° F., approximately. A 12-stone man has about 1 st. or 14 lb. of blood in him, therefore his heat will heat his blood 428° F., which, allowing for his original heat of 98·4° F., and the greater heat required to boil blood than water, leaves the above statement true with a substantial margin.

Phosphorus (P): A non-metallic element that is a very important constituent of nerves and brain-matter, and so belongs very much to organic material, though when combined with H and O in the form of phosphoric acid (H_3PO_4) it also is found in minerals and other inorganic substances. Its chief hygienic importance lies in the fact that it used to, and still does in the red form, enter largely into the composition of match-heads, and the workpeople in match manufactories used to suffer from chronic phosphorus poisoning; this, under improved hygiene, has now almost entirely disappeared. In a pure state it is very dangerous stuff to handle, owing to the ease with which it oxidises or burns. Its dose in medicine is very minute—$\frac{1}{100}$ gr.

Potassium (K) is important as the chief metallic constituent of the solids of the body, and with sodium and the compound ammonia (or Am) forms the alkalies.

Silicon (Si): It is a metal, but of no interest beyond the fact that it forms the bulk of most bricks and clay, that glass and stone or earthenware are all largely composed of silicates. The sand of the seashore is also largely composed of silicon.

Sodium (Na) is important in physiology, and therefore in hygiene as the chief metallic constituent of all the salts dissolved in the liquids of the body, and therefore requires to be provided in food in fairly large quantities; it is known as an alkaline metal or alkali.

Sulphur (S): Only of interest in that when oxidised or burnt it forms a gas with the formula SO_2, which is a powerful and

penetrating (being a gas it can get into cracks, etc.) disinfectant, and one which is freely used for disinfecting the rooms in which patients suffering from infectious diseases have been nursed. When combined with hydrogen (H_2S) it forms a gas with a horrible smell, very apparent when an egg (which contains some sulphur) has gone rotten.

As a last general remark on the elements it should be stated that with the exception of sundry metals, lead, silver, and gold, for example, a few non-metals such as sulphur, and some natural gases, oxygen and nitrogen, for example, very few of the elements are found as such in nature ; they all exist as salts (oxides, chlorides, sulphates, carbonates, etc.), and require special chemical means to obtain them even in comparative purity.

Such being the case, we must now proceed to show how the world of natural objects is built up ; this is entirely and absolutely done by what is known as chemical action, which we will now define.

Definition 2.—**Chemical action** is that process which takes place when two or more elements or compounds are brought together under such circumstances (the circumstances may either be in the nature of physical forces such as the application of heat or electricity or solution, or it may be that the objects brought together have a natural tendency to combine, *e.g.*, most acids and bases) that they unite atom to atom or molecule to molecule so intimately that something new is formed which was not there before—this is termed a chemical compound.

Definition 3.—**A chemical compound** is the body formed as above by chemical action ; it usually differs altogether in physical and chemical properties from the original elements or compounds that took part in its formation. For an extremely simple illustration we may take $NaCl$ or sodium chloride or table salt ; for a more complicated one take a piece of wood formed almost entirely out of O, H, and N, together with Na and K under the influence of vegetable life, or a piece of meat made out of the same elements by animal life. When the compound is very complicated and analysis is incapable of showing the exact manner of the combination of the elements in a substance, such substance is usually spoken of as a complex chemical

compound, *e.g.*, proteid food stuffs ; such complex bodies are commonly organic.

The manner in which all the above is represented in books on chemistry is as follows.

The fact that two or more elements have combined is indicated by writing the symbols for the elements one after the other (like the letters of a word, only that capital letters are employed)—this is known as the (chemical) formula of the substance in question. Then the process of bringing two or more elements or compounds together is indicated by the symbol + (plus) ; the result is then indicated by the symbol = (equals). The number of atoms of each element in a compound is indicated by small figures at the bottom. Suppose we dissolve a little common salt in water and a little nitrate of silver in some more water and add the two solutions together, it takes a long time and is very awkward to write down in full and describe the whole process but it is easily written down as :

$NaCl$	+	$AgNO_3$	+	H_2O	=	H_2O	+	$AgCl$	+	$NaNO_3$
Sodium chloride	+	nitrate of silver	+	water	=	water	+	silver chloride	+	sodium nitrate.

A nurse has no need to try and learn this formula ; it is merely an example.

Again, what happens when lime is added to hard water to soften it? The formula for the operation is :

$CaH_2(CO_3)_2$	+	$Ca(HO)_2$	=	$2CaCO_3$	+	$2H_2O$
Bicarbonate of lime, somewhat soluble	+	lime water	=	carbonate of lime, very insoluble	+	water.

Simply boiling the water may effect the same purpose, and is thus represented :

$CaH_2(CO_3)_2$	+	heat	=	CO_2	+	$CaCO_3$	+	H_2O
Bicarbonate of lime				escapes as a gas		falls as a precipitate to the bottom.		

Definition 4.—A mixture differs from a chemical compound in this respect, that the several elements or compounds which are put together in the mixture do not unite so closely as to

form a new body; they remain side by side, each retaining its own characters, and if they are all solid they can be seen with a microscope so lying, and they can, as a rule, again be separated by simple physical means. If gases or liquids are in question the characters of a mixture are the respective characters of its constituents; they have not combined so as to give new characters which were not there before.

An illustration or two taken from hygiene will help to make the matter clearer; thus air is a mixture of oxygen, nitrogen, CO_2, and watery vapour. Very simple means, almost mechanical, will separate them; cooling will fetch the water out, and burning a candle in it will fetch out the oxygen; the CO_2 can be got out by bubbling it through lime-water. But now pass electric sparks through the air and at once chemical union takes place, oxygen combining more closely with oxygen to make ozone, and oxygen combining with nitrogen to form oxides of nitrogen, each of which may be identified by its smell and taste, the originals (O and N) being odourless and tasteless.

Again, dust is a mixture of many things, all or most of which can be seen mixed up together under the microscope, and many of which can be separated by just throwing the dust into water. The lighter particles, cotton-wool and other fibres, etc., float on the top, while the mineral (*vide* p. 20) constituents sink to the bottom.

ACIDS, BASES, AND SALTS.

A nurse has no need to bother herself with any very strict definition of these terms, but she can hardly read a few paragraphs of the chemistry of daily life without wanting to know what they mean. Unless we enter deeply into the problem it is impossible to define them except in a sort of circle thus:

An acid is a substance which when combined with a base forms a salt.

A base is a substance which when combined with an acid forms a salt.

A salt is formed by the union of a base with an acid.

Acids and bases are commonly, or rather can be, arranged in order of potency, *i.e.* of attraction for one another or power to

unite; the stronger acids can turn out the weaker ones from a combination or salt.

It is very easy to give a few illustrations of these bodies which will, and do, come under a nurse's notice every day in her work.

Thus of **acids** she will find nitric, or HNO_3; sulphuric acid, or H_2SO_4; hydrochloric, or HCl, and oxalic (the corresponding salts are called nitrates, sulphates, chlorides and oxalates) used more or less constantly in urine testing and cleaning of metal objects, etc., and carbolic acid, used as a surgical dressing and as a disinfectant for drains, etc., and her knowledge of them should at least go so far as to know that they are one and all rather dangerous things to play with or taste, and that they will readily destroy dress fabrics. It is also as well to add a word of warning in regard to nitric acid: not only is it a powerful acid in itself, but it is also what is known as a powerful oxidising agent, and if incautiously added to certain organic fluids, such as turpentine, or even solids, such as cotton waste, may lead to disastrous burning or explosive results. I mention this point because a nurse actually lost an eye by the bursting of a bottle which she was cleaning with strong nitric acid; the bottle had contained turpentine.

Again, should a nurse have the misfortune to upset a bottle of nitric or hydrochloric acid, let her not wipe it up with her face too close to it, as the fumes of these very volatile acids are extremely dangerous to breathe; let her at once pour some water on the place, or, if handy, some potash or soda. In the urine-testing cupboard liquor potassæ is always at hand with the nitric acid.

The only point common to all these acids and any others that a nurse is likely to meet with is that they all contain hydrogen, and hydrogen so combined with the other elements that it is capable of being turned out and its place taken by another base, thus forming, as a matter of fact, a salt.

Of **bases** she will come across bottles of soda or NaHO, potash or KHO, and ammonia or AmHO, all in the test cupboard; these are all powerful bases and known as the alkaline bases *par excellence*. All the metals are bases and a good many

non-metallic elements ; other more compound and complicated bases are an innumerable number of so-called organic bases, morphia and strychnine, for instance.

Of salts it may pretty truthfully be said that nearly everything she sees, when analysed, is found to be made up of salts of one of the thousands of acids combined with one or more of the thousands of bases, but in her hygiene there are just one or two salts which are particularly interesting ; for instance, what happens when soap is used to wash with. Soap is a salt, the base being potash (soft soap) or soda (hard soap) and the acid what is known as a fatty acid (fat is a combination of glycerine as a base with fatty acids, and all our commercial glycerine comes from soap manufactories, the business of which it is to take glycerine out of fat and substitute potassium or sodium for the glycerine). When the soap is dissolved in water containing salts of iron, lime, etc., *i. e.*, in hard water, the acid part of these salts takes the K or Na out of the soap, which then goes into a curdy sort of material of no use for washing purposes, and it is only when all these salts have satisfied themselves (hence the extravagance of hard water for washing purposes) with the soap that the soap *as such* can simply dissolve in water to form what is known as lather, the useful substance for cleansing purposes, because this lather can combine with the dirt and natural grease of the body and make them soluble in the water, or at least mechanically remove the dirt from the hands. I might remark that it is quite possible to clean the hands, etc., with *cold* water and soap.

Other salts which occur in a nurse's work are all the hypodermics she gives, in which morphine, strychnine, atropine, etc., form the bases, and hydrochloric, sulphuric, acetic, etc., are the acids, the salt being dissolved in a small quantity of water.

PHYSICS.

This branch of learning deals with the behaviour of matter under the influence of natural forces, and we shall deal with it under two or three headings.

(1) The physical, as opposed to the chemical, constitution of matter.

(2) Heat as a physical agent.

(3) Electricity.

PHYSICAL CONSTITUTION OF MATTER.

All matter is generally stated to belong to one of three kingdoms, viz. the mineral kingdom, the animal kingdom, or the vegetable kingdom. The mineral kingdom consists essentially of things which, so far as we know, have never had life—they are merely dead masses of chemical elements or compounds, or mixtures of elements and compounds—and atoms and molecules form the fundamental basis of their substance. On the other hand, the animal and vegetable kingdoms consist essentially of things which are either now living or are known to have been living at some time or other. Now the fundamental unit of all living things is the cell, and everything living can be seen by the microscope to be composed of one or many cells; there are

exceptions, but with these a nurse need not trouble herself except to remember that the germs or microbes of disease, with the ideas of which she will later become very familiar, are so small that we are unable to see a cell form in them, although from other considerations we know that they are alive.

Definition 5.—**The definition and functions of a cell** have much more to do with elementary physiology than with our present subject, the constitution of matter. Here we need only say that a cell possesses the following characters: (*a*) It has a definite shape, varying enormously with the nature of the cell; (*b*) it has a structure of material consisting generally of very complex substances; (*c*) it has contents (generally of a more or less liquid and complex nature) which are not, so to speak, part of its structure, but exist there for certain purposes and consist of organic matter equally with the cell; (*d*) lastly, while living, it performs certain functions which in the aggregate constitute "life." A sponge full of water will give a nurse a sufficiently accurate idea of a cell: it has a shape, it consists of complex material, and the water may correspond to the cell contents.

Definition 6.—**Organised Material or Matter.**—Now the substance or material, as well as the contents, of a cell can be analysed down into more simple (often very complex all the same) chemical compounds constituted of atoms and molecules, but so long as objects of definite structure like cells can

be seen under the microscope the thing that is being investigated is spoken of as organised, and this will serve as a definition of *organised material*, that is, something in which actual cells can be seen in some fairly definite arrangement.

When, however, structure has been so far broken down that nothing like a complete cell and arrangements of cells can be seen, or when we are looking at mere contents or fragments of cells, then it is usual to speak of it as **organic matter**, *i.e.* matter derived from an organ which is now alive or has had life, but not necessarily showing any cellular structure.

Now, when such organic matter is further analysed by chemical means into its simpler constituents it is found to consist almost entirely of the four elements —carbon, oxygen, hydrogen, and nitrogen (there are smaller quantities of other elements in them, *vide* p. 11), and consequently by a little extension of argument it is customary in analysing a complex substance to speak of those parts of it which mainly consist of these four elements as the organic constituents of the substance under analysis, the remainder being called the inorganic, or metallic, or mineral, or other constituents. In physiology a nurse will further learn that of organic food materials there is an important distinction to be drawn between those which do and those which do not contain nitrogen, but this need not detain us here; it is merely another connecting link between the constitution of matter and physiology.

Definition 7.—**Inorganic matter** obviously means that which is not organic, and therefore that which is not obviously and directly the remains of animal and vegetable tissues—never had life, in fact. Such matter is mostly metallic, for the metals, except sodium, potassium, calcium (or lime), and iron do not enter much into organic matter. It is also in many senses the equivalent of mineral matter, but chalk, a typical mineral, is composed of the dead shells of animals that once lived and is said to be the mineral or inorganic remains of these animals, and when in analysing any organic matter by heat a balance remains unburnt this is spoken of as ash or inorganic residue.

Definition 8.—**Metallic matter or material** obviously means composed of metals.

To define a metal in simple language is impossible, and in science metals can only be defined as a group of elements possessing certain qualities, such as toughness, ductibility, or capability of being drawn into wire, conductivity of heat, basicity in combination, malleability, or capability of being hammered into thin sheets, etc., more or less in common, and none of these qualities appeal much to the mind of a beginner, and certainly a nurse must be content with examples such as copper, gold, silver, and iron.

Definition 9.—**Non-metallic,** not a metal, only definable by negatives; and again we can only give examples: sulphur, iodine, chlorine, phosphorus are common non-metallic elements.

Definition 10.—**Mineral,** I presume, literally means got from a mine or quarry, and as a matter of fact

mineral matter is nearly the same thing as earthy matter, and with a few exceptions, of which coal (which is pre-eminently organic) is the chief example, mineral matters are really inorganic or metallic. All stone used for the road, etc., is spoken of as minerals, and again, when coal has been burnt we commonly speak of the ash as mineral matter, the organic constituents having been burnt off.

FORMS OF MATTER.

Proceeding still along the same lines we can perceive that all material seems to take one of three physical forms—gas, liquid, solid ; some, it is true, such as treacle, paste, mud, etc., seem to be neither quite liquid nor quite solid, but these exceptions need not trouble us. We will endeavour to make clear how the definition of these three terms depends upon the idea of atoms and molecules, and how the definitions in turn explain some physical laws which come very much to the front in personal hygiene.

Definition 11.—**A natural gas** is a substance the atoms or molecules (a gas may be an element or a compound) of which have a tendency always to separate from one another at ordinary temperatures, and will so separate unless restrained by force.

Definition 12.—**A vapour** is the gaseous form (or gas) of something which is naturally (the word is not usually applied to natural gases except in a special—usually offensive—sense) at ordinary temperatures a liquid or solid, *e.g.* we speak of the vapour

of chloroform or ether, of water, of camphor. Usually it is heat that causes these bodies to vaporise, in fact, by strict scientific reasoning it is always heat (*vide* p. 32), and it is worth while to note that, given sufficient heat, all solids and liquids can be converted into the form of vapour.

Definition 13.—**A liquid** is a substance the atoms or molecules of which have no great tendency to separate from one another at ordinary temperatures, though they will in most cases ultimately do so, *e.g.* water and many other common liquids, but have, on the other hand, no particularly strong tendency to adhere to one another, so that, to take an example, we can easily plunge our hands into water or mercury, the mere pressure of the hand or finger being sufficiènt to separate some of the atoms or molecules from one another (the hand or fingers lie between such atoms or molecules).

Definition 14.—**A solid** is a substance the atoms or molecules of which have a very great tendency to stick to one another; they cannot be separated without a degree of physical violence or heat usually much greater than that required for liquids.

At the present moment we will not discuss these definitions further, but merely state that they explain the diffusion of gases (*vide* ventilation), the evaporation of water (*vide* perspiration), etc.

Definition 15.—**Solution.**—When a gas or a solid is introduced into a liquid and seems to disappear without any other noticeable chemical effect we have

a solution of the gas or solid in the liquid. Scientists hardly seem able to give us a satisfactory explanation of the phenomena, and the above may well stand, with this additional idea that—solution is probably "a mechanical mixture of atoms or molecules" (*vide* p. 5), the material dissolved being in a state of finest (molecular) subdivision.

Definition 16.—**Emulsion.**—This word is used in the physiology of digestion and should therefore be defined; moreover, milk is an emulsion of fat in a saline solution, and steam is an emulsion of water in air, so the idea underlying it is common enough. We have just defined a solution as a mechanical mixture in which the dissolved substance is atomically or molecularly divided. An emulsion may be similarly defined as a mechanical mixture in which the emulsified substance is merely microscopically divided, *i. e.* the particles are still coarse enough to be seen with the microscope. (Milk under the microscope can easily be seen to consist of fine globules of fat floating in a liquid.) There is also the further idea conveyed by the word, viz. that the finely divided particles of the emulsified substance shall float in the menstruum or material that is acting as the emulsifier, thus making an emulsion different from a finely divided precipitate, which latter soon sinks in the menstruum.

Definition 17.—**Volatility and Volatile.**—The simple scientific meaning of these words is, when applied to liquids and solids, "a natural tendency to

convert themselves into a gas or vapour," to evaporate in other words; a condition profoundly modified by heat (*q.v.*).

All gases and practically all liquids are volatile, the former in a great degree, for it is their essential characteristic to expand or diffuse when not mechanically restrained by an obstacle such as a closed box or bottle, *i.e.* for the atoms or molecules to run away from one another; the latter vary enormously in their volatility, from such liquids as ethyl chloride, chloroform, and ether, which are extremely volatile, through water, which is of medium volatility, up to glycerine and some oils which are practically non-volatile at ordinary temperatures. Of solids the vast majority are non-volatile at any ordinary temperatures, but some are readily so, *e.g.* camphor, albocarbon, etc., even at ordinary temperatures of the atmosphere, and all can be made volatile, or at least can be volatilised, by extreme heat, but *vide* p. 51.

When matter is thus being changed from a liquid or solid form into a gas a great deal of heat is absorbed or lost, or used up in causing the changed condition, a subject we shall notice more fully under physics of water, but we may note here what will soon be a familiar example to a nurse in hospital, viz. the freezing of the skin for small operations by spraying it with such very volatile bodies as ethyl chloride or with ether.

Definition 18.—**Weight.**—The last general property of all matter is that it has weight or a tendency to fall to the ground if not supported. A balloon floating and rising in the air would seem at first sight to contradict this definition, but it is not really a contradiction; the explanation is that the balloon and its contents

so rising are together lighter than the air, the space of which they occupy, just as a piece of cork is lighter than the water on which it floats. The weight of a body is really the pull of the earth, by the action of gravity, on a body ; to define it more accurately would take us out of the depth of an elementary work, but we may just add that the weight of a body is identical with the pressure such body exerts on its support ; this explains such phrases as "atmospheric pressure," which means the weight of the atmosphere over a given spot (*vide* p. 60). Weights are measured by pounds or multiples and fractions of a pound, or by grammes and multiples and fractions of grammes—a gramme = 15·432 grains (*vide* also p. 165 for definition of specific gravity).

Heat, light, sound, and electricity have no weight, being only names applied to states of matter and not matter itself.

HEAT.

HEAT enters very largely into a nurse's domestic hygiene, and we shall have to discuss it pretty fully, though much of what is related may be omitted by the beginner. We shall discuss it in the following order:

(*a*) What heat is, and its appreciation by the skin.

(*b*) How heat is measured, with illustrative temperatures.

(*c*) How heat is produced.

(*d*) How heat is distributed.

(*e*) What heat does.

WHAT HEAT IS.

It is a fact, apparently, that heat is a condition of vibration, or to-and-fro movement, of the atoms or molecules of the substance which is hot; this statement seems very abstruse and difficult for an elementary work, but for all that, if the reader has appreciated the idea of atoms and molecules on p. 4 and p. 5, she will find it very easy to understand and follow in her mind all that is here stated.

A simpler way to look at heat is to compare it with water: just as water always runs downhill, if not

prevented by an obstacle, so heat will always run downhill, as it were, from a hotter body to one that is colder; the comparison fails in this respect, that heat, being without weight, escapes in all directions into the colder place, upwards, downwards, and sideways, only influenced by the fact that the other body or place *is* colder. Further, we can make a thing "water-tight" so that water cannot escape from it; we cannot make a thing "heat-tight" so that heat cannot escape; the Thermos flask is perhaps the nearest approach to such a heat-tight vessel, but this will eventually allow its contents to cool, though with the stopper tightly screwed home it will never allow them to escape.

This analogy with water helps one to understand quantities of heat as opposed to the degree of temperature to which any body is heated. Thus, obviously, a big jug of hot water contains a greater quantity of heat than a thimbleful, though a thermometer placed in each of them may register the same degree of heat for the water.

JUDGMENT OR APPRECIATION OF HEAT.

Let the reader perform a very simple experiment: Take three basins of water, one at 40° F., another at 75° F., and the third at 110° F.; let her put the left hand into the one at 40° F. and her right into the one at 110° F. for a couple of minutes, then put them both into the one at 75° F.; to the left hand this will appear quite hot, to the right it will appear

quite cold. The application of this little experiment will explain a hundred different experiences in one's daily life, remembering that 98·4° F. is the natural temperature of the body, and therefore a temperature by which, or perhaps better, from which, we naturally judge the heat of things so as to apply the terms warm, hot, or cold.

DEGREES OF HEAT AND HOW THEY ARE MEASURED.

Heat is measured by an instrument called a "thermometer" or heat measurer. It is well to draw attention to the fact that these instruments do not measure quantities of heat; they measure only its quality, so to speak. For very high and very low temperatures all sorts of thermometers are made, but for ordinary purposes there is only one form, viz. a glass tube closed at both ends, up which some liquid, usually either mercury or coloured spirit, rises under the influence of heat and sinks again (in the clinical thermometer for which mercury is always used it requires to be shaken down—the tube is so small) as the heat is withdrawn.

Inasmuch as the registering of a patient's temperature or that of his room is an important item in a nurse's work we must describe the thermometers in ordinary use rather fully.

In making them there are two very natural temperatures which are used to mark the highest and the lowest temperatures to be recorded (commonly

a few lower degrees are marked for use in winter, and most, indeed all, thermometers in ordinary use only show a portion of the scale between these two points). These are: (1) That of boiling water; (2) that at which water freezes, or rather, at which ice melts. In the Centigrade thermometer used on the continent these are marked as 100° and 0° respectively; in the Fahrenheit thermometer used in England they are marked as 212° and 32° respectively. We need not enter into the reasons for these figures, but the figures themselves must be remembered.

Now between the temperature of melting ice and that of boiling water, mercury and spirits of wine or alcohol expand an equal amount for each equal addition of heat, and hence, having marked the position of the top of the column of mercury or spirit when exposed to melting ice and boiling water, we have only to divide the intervening space into 100 or 180 ($212 - 32 = 180$) equal spaces and each of these small spaces is a degree.

Figs. 1–4 represent four thermometers. Let the reader notice that the ordinary ones are constructed to show any temperatures between freezing and boiling water, the clinical ones are only constructed to show temperatures about the body heat, *i.e.*, between 95° and 110° F., and 35° and 43° C.

N.B.—Don't try to use your clinical thermometer for very hot water, or you will break it by the force of the expansion of the mercury inside.

Figs. 1 and 3 are Fahrenheit thermometers.

Fig. 1 would record any temperature from 32° to

Fig. 1.

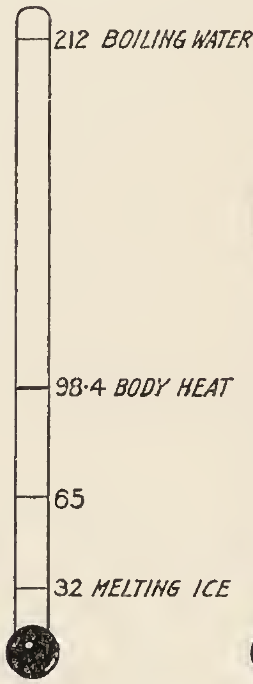


Fig. 2.

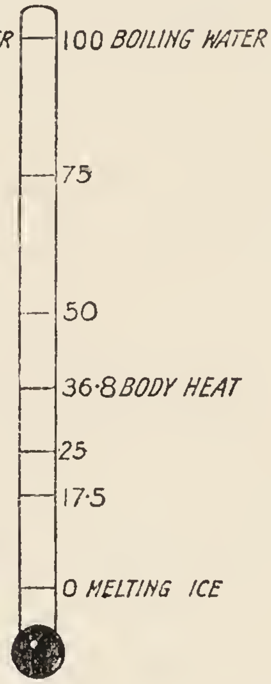


Fig. 3.

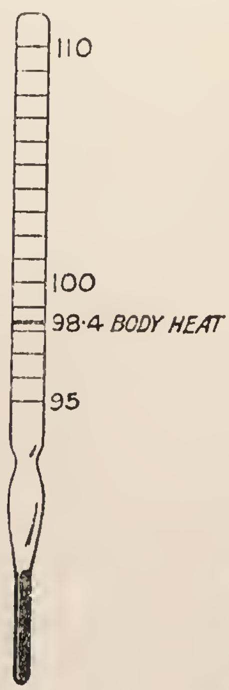
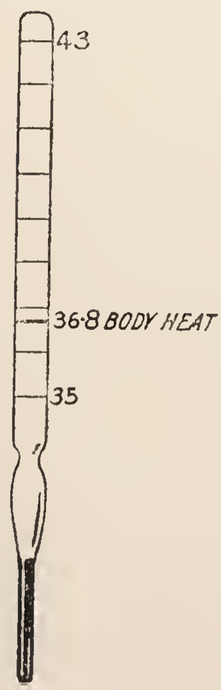


Fig. 4.



212°; Fig. 3 will only record temperatures between 95° and 110°, and it is usually spoken of as a clinical thermometer. Similarly, Figs. 2 and 4 are Centi-

grade thermometers. Fig. 2 would record any temperature from freezing 0°, to boiling, 100°; Fig. 4 would record any temperature from 35° to 43°, which are practically the limits of the body temperature in health and disease, and hence the thermometer is called a Centigrade clinical thermometer.

Inasmuch as a nurse may be called upon to go to the continent to nurse a patient, it is not out of place to show how a given temperature in one may be converted into the scale of the other—supposing that she or the patient or the doctor is more familiar, or only familiar, with the one which is not available.

The Fahrenheit scale, then, takes 32° (the "°" is the symbol for degrees) as the temperature at which water freezes; it also takes 212° as the temperature at which water boils under an atmospheric pressure of 760 mm. mercury, and therefore subtracting 32 from 212 leaves us 180 degrees between boiling and freezing.

Now the Centigrade scale (invariably used in France, Germany, etc.) more rationally, its users think, takes 0° as the freezing-point of water and 100° as the boiling-point, or 100 degrees between the two points.

It therefore follows that 100° C. must be equal to 180° F. or $10 = 18$, or $5 = 9$, or $1 = \frac{9}{5}$, and hence it is very easy to see the rule for converting one into the other, and as an example let us see what the ordinary 98·4° F. or body-heat works out at on the Centigrade scale. We must first subtract the 32° with which

we started; this leaves us with 66·4 of the degrees between freezing and boiling, and every 9 of these are equal to 5 of the degrees of the Centigrade scale; we must therefore divide by 9 and multiply the result by 5, or what is simpler, multiply 66·4 by 5 and divide by 9. The result is 36·8 (thus $66·4 \times 5 = 332$, divided by $9 = 36·8$, or nearly 37). These decimals are a bit awkward for the poor arithmetician, but an easy figure to remember is that 40° C. = 104° F. exactly; this is a somewhat dangerous point for the body to be at.

On the other hand, suppose the temperature of a fever patient were found on a Centigrade thermometer to be 39°, what is this in Fahrenheit? We must obviously multiply by 9, divide by 5, and then add 32 ($39 \times 9 = 351 \div 5 = 70·2 + 32 = 102·2$).

DEGREES OF HEAT.

It is not without some importance for a nurse to realise that everything has heat, very commonly that of the air, or atmosphere to which it is exposed, unless, of course, it is in the sunshine or within the influence of some artificial source of heat. (I put this note in because I once asked a nurse, "What is the temperature of a mackintosh?" and she could give me no reply; the right answer obviously should have been, "That of the atmosphere to which it is exposed.") In other words, molecular motion is going on in everything, and the temperature of a body is only a question of the rapidity of this molecular motion.

It will make the subject a little more interesting to quote some few temperatures and terms that are applied to them.

(1) $-273°$ C. or $-459{\cdot}4°$ F. is termed absolute zero, and here, heat, *i. e.*, molecular motion, is supposed to cease entirely; the lowest yet reached by scientific means is about $-250°$ C., but from there up to No. 2, temperatures belong to science, not to hygiene.

(2) About $-50°$ C. or $-58°$ F. is the coldest natural temperature in the Arctic regions that has been met with by explorers.

(3) From this point up, say to $-10°$ C. or $14°$ F. can hardly be spoken of as anything but unusual degrees of frost—very low temperature.

(4) From there to $0°$ C. or $32°$ F. are the common degrees of frost met with in winter, and these are spoken of as ordinary winter temperatures.

(5) From $0°$ C. or $32°$ F. up to about $10°$ C. or $50°$ F. are spoken of as ordinary low autumn or mild winter temperatures. Very cold baths.

(6) From about $10°$ C. or $50°$ F. up to, say, $40°$ C. or $104°$ F. are spoken of as the ordinary temperatures of the air—cold, mild, or hot—as we approach and recede from the extremes.

A temperature of from $60°$ F. to $70°$ F. ($15{\cdot}5°$ C. to $21°$ C.) is considered a fair temperature for an ordinary working room, perhaps a bit more comfortable towards the higher limit, but over 70 it is too hot for the comfort of most people to remain in for long while at work.

(7) Temperatures between $40°$ C. or $104°$ F. and $100°$ C. or $212°$ F. are hot temperatures found some-

times in exceptional circumstances in work-places, such as mines, iron foundries, etc., which have an interest for public hygienists; they are also the temperatures between which with a little latitude all cooking is done, and, therefore, come very much into personal or domestic hygiene, of which proper cooking forms no small part.

(8) A red heat of iron, etc., is in the neighbourhood of 500° C. Oil boils about 300° C. to 350° C.

(9) Higher than this we get the temperature of furnaces, electric and other, ranging up to 5000° C.

Special thermometers and materials are obviously required for registering and utilising these heats, at the limit of which we may incidentally remark fire bricks are burnt (oxidised or vapourised, *vide* p. 21, or p. 48), like paper in an ordinary fire.

HOW HEAT IS PRODUCED.

Heat is spoken of as arising from two sources—natural and artificial. "Natural" is the term applied to the heat of the sun, about which we have nothing to say, except that it is all radiant, *vide* below; also to the heat of living things, about which we shall have a great deal to say, *vide* below. "Artificial" is the term applied to heat which is produced by physical and chemical forces in the world either by nature or by man's ingenuity, and of these there are three known principal forms, viz. electricity, friction, and chemical action, commonly oxidation.

Electricity as a source of heat.—This subject is too deep for an elementary book; suffice it to say that

heat *is* generated by electric currents. A great amount of heat is felt coming from electric lamps, and electric heaters are now a common domestic means of heating rooms; for their advantages and disadvantages respectively, *vide* p. 139.

Friction as a source of heat.—On this we need say nothing except that it is the means whereby a match is lighted when struck in the ordinary way, and it accounts for the sparks from a railway wheel when the brakes are put hard on, or the sparks that fly where metal strikes flint.

Chemical action and oxidation as a source of heat.—These in the realm of domestic hygiene are the common sources of heat—candles, lamps, and fires all depend on oxidation for their heat.

Of chemical action, apart from obvious oxidation, we have only one illustration and warning to give: When water is added to a strong mineral acid (sulphuric especially, nitric and hydrochloric in less degree) great heat is produced, a result of which may be that the bottle may become too hot to hold or may burst from the heat; in either cases a nasty accident may occur. The act of dilution might fall to a nurse to perform for a doctor or in the wards.

Upon the subject of oxidation as a source of heat there is a good deal to be said: it is important to get clear ideas upon the matter, because it explains many little domestic incidents. Let it be understood that burning, combustion, and oxidation in our present connection all mean one and the same thing and that a flame is merely burning gas. The visibility of a flame is another matter and one a

nurse may neglect. Wherever oxidation is going on, heat is being set free, or being generated as it is incorrectly termed.

Now let us follow step by step the lighting of a candle, a lamp, or a fire, and explain what happens. The facts as they occur are as follows: A match is struck by friction and bursts into flame; the flame is applied to the candle or lamp-wick or to paper; the candle or lamp straightway continue to burn, and the paper lights the wood, which in turn lights the coal, which then continues to burn.

Point 1.—Heat from another source (friction in the case of the match) is required to start oxidation (there are a few exceptions to this, but they need not trouble us here); the heat then produced by the primary oxidation is generally sufficient to cause further burning or oxidation, so that the process goes on. We might incidentally remark that the actual temperature of the flame of a burning match is somewhere in the neighbourhood of 500° C. or 932° F., but the actual heat required to start oxidation in the phosphorus of the match head is much less than this (the heat of the hand will cause pure yellow phosphorus to burst into flame).

Point 2.—For the process to go on three things are obviously necessary: (*a*) More material to be oxidised; (*b*) oxygen in plenty to oxidise it; (*c*) heat sufficient to cause the oxygen and the material to combine.

(*a*) Is of no importance; it is only another way of

saying that the match, the candle, the lamp, or the fire burns itself out. It explains, however, why a fire gives more heat than a candle—there is more material to oxidise.

(*b*) Is exceedingly important as a practical point, for it tells one how to put out a fire (*vide* also p. 121), viz. to cover up the burning part so that air (which means oxygen) cannot get to it; this is the meaning of wrapping a burning person in a hearthrug, coat, or cloak at once as closely as possible; it keeps the air out of the burning area. If the burning object is small the hand or any article may be sufficient for the purpose, and the same object is served by crumpling up the burning article.

For further illustrations of insufficient oxygen, *vide* p. 51; of what heat does, p. 46 *et seq.*; and also of how to get a fire to burn brightly, p. 51.

(*c*) Explains why we can blow a candle out with the breath; the breath is cold enough compared with the heat of the candle, and there is enough of it compared with the candle flame to cool the burning spot down below the temperature at which wax can oxidise sufficiently rapidly to cause a flame; it also explains the use of water to put out a fire; it is a part also of the explanation of (*b*), for the coat or hearthrug helps to cool down the burning spot. It explains how the improper use of the bellows may defeat its own object by cooling the lingering spark of fire too much.

Point 3.—Combustibility, or inflammability, or the

ease with which a thing burns, is a very variable factor (*vide* also p. 121), dependent on (*a*) the actual chemical nature of the article—phosphorus, for instance, is very easily combustible at any temperature, charcoal or carbon requires a fairly high one—and (*b*) the physical condition of the article as regards its solidity; compare the burning of a single sheet of paper with that of a book. As a scientific fact this may be devoid of interest to a nurse, but not so its practical application, which lies in the means that may be taken to resuscitate a dying fire or to light one more rapidly than by the ordinary means. The point here upon which one must be very emphatic is, do not use any liquid means by bringing the bottle or can to the fire; both petrol and paraffin are used for the purpose, but let me urge most strongly upon a nurse never to bring more than a dessert-spoonful of such dangerously inflammable liquids even into the room in which the fire is; most disastrous accidents have been thus caused. A little sugar may be safely sprinkled on glowing cinders to start a flame if nothing in the shape of small chips of wood or paper is handy.

As regards the material out of which clothes are made, a nurse may well remember that dry cotton and linen are very easily lighted, silk less so, and wool is less combustible than any clothing material unless it be leather. The danger of flannelette lies in the constituents other than the wool in it, in fact, I am told flannelette is all cotton (*vide* p. 105, under clothing).

Point 4 : The products of combustion.—In the presence of a plentiful supply of oxygen these are carbonic acid CO_2, water H_2O, in the form of vapour, ammonia NH_3, and a few other less simple but still comparatively simple bodies, which all escape from the burning spot into the surrounding atmosphere. They are practically the same products as those produced in the more complicated system of combustion which goes on in the human body, urea in the body being the representative of nitrogenous oxidation rather than ammonia. It would be simpler to say that the processes in the body are in effect the same as those in a fire with similar end products. The disposal of these products of combustion, or rather the way in which they dispose of themselves, is a most important point in warming and ventilating a room (*vide* p. 139, also p. 131).

Point 5 : The amount of heat produced.—From a given quantity of ordinary inanimate fuel—oil, wood, coal, etc.—this can be calculated exactly; it is of no material consequence in domestic hygiene except the very obvious conclusion that to economise fuel and get the greatest heat out of a given quantity we must take care to keep a very free supply of oxygen going (for *combustion in the body, vide* p. 10).

HOW HEAT IS DISTRIBUTED.

We have already mentioned incidentally the first great law of heat, viz. that it is always escaping from a hotter substance to a colder one. We may now

proceed to see how this occurs and how it comes into domestic hygiene. The methods themselves of heat dispersal are convection, conduction, and radiation.

Convection simply means the carrying of heat bodily from one place to another; the simplest illustration of this is the domestic warming-pan or hot-water bottle by which heat is carried in a vessel to the bed from the kitchen boiler or fire; another illustration is the convection of the heat in the body by the blood: the heat developed in a muscle or gland at work warms the blood in the muscle or gland, and the circulation of the blood convects this heat to other parts of—all over—the body. These are illustrations of gross convection; in speaking of the effects of heat on gases and liquids we shall see convection at work on atoms and molecules.

Conduction is the passage of heat along a body of continuous solid structure, the atoms and molecules of the body not being able to visibly change their position (*vide* also p. 22).

Now, suppose that one part of any solid thing (a poker, a nightdress, etc.) is hot, then the rapidity with which the heat of that part is transferred to the rest of the solid body is spoken of as the rate of conduction of heat of that substance (of which our imaginary article is composed). In this sense we can get a measure of rates of conduction, and we possess a complete record of the conduction rates of all common substances and can divide materials up

into good and bad conductors. Speaking generally, the metals, especially copper, silver, gun-metal, gold, etc., are very good conductors of heat, and right down at the other end of the scale, as the very worst conductors, are found most animal and vegetable materials, also water and gases under pressure or in confined spaces. A vacuum is perhaps the worst conductor known. It is especially necessary to mention organic materials because nurses think that linen and cotton are good conductors of heat; they are so only in comparison with wool (*vide* p. 106).

Bearing in mind what was said on p. 27 about appreciation of heat, a nurse may perform a very simple little experiment to help her to appreciate this conduction of heat. Let her touch two objects: one metallic, such as the handle of a door, the other organic, such as the wood of the door or a bit of blotting-paper; all these, simply resting in a room, are really at the same temperature, viz. that of the room at the place where they are, but the metallic object will appear colder than the wood or paper if both of them are colder than the skin of her finger, and, *per contra*, will appear hotter than the wood if both are warmer than the skin of her finger. The reason is simple: the moment the finger and the object are in contact heat at once begins to escape by conduction from the hotter body (finger or object) into the colder one (object or finger), and it does this the more rapidly the better the conducting power of the object touched, *i.e.* the more easily the heat can

escape, and hence for the moment it feels hotter or colder as the case may be. This explains the fact that sheets feel colder than blankets (*vide* p. 107), and is, in fact, the chief point to be borne in mind in connection with ordinary under-clothing materials and the nature of the floor upon which one stands with naked feet. Linoleum is a better conductor than carpet or blanket or cocoanut matting or cork.

THE PASSAGE OF HEAT IN LIQUIDS AND GASES.

Gases and liquids (except mercury, which is a metal) are bad conductors of heat in the strict sense of conduction from molecule to molecule without change of position. It is important to get clear ideas of how heat is distributed through these media —molecular convection—because they are the great methods which come into play in warming a house or a room and in providing a hot-water supply throughout a house, and therefore are important subjects in domestic hygiene.

Referring back to our definitions (p. 21) of gases and liquids and solids, we saw that they were defined by the relative attraction of the atoms or molecules for one another, or, to put the matter the other way round, by the relative ease with which their molecules moved on one another and so could shift their positions in a given bulk of the medium. Now physical means (pressure and solid objects) and heat are the two great causes that actively bring about or permit

to be brought about this shifting of the atoms or molecules, and we now have to deal with the action

FIG. 5.

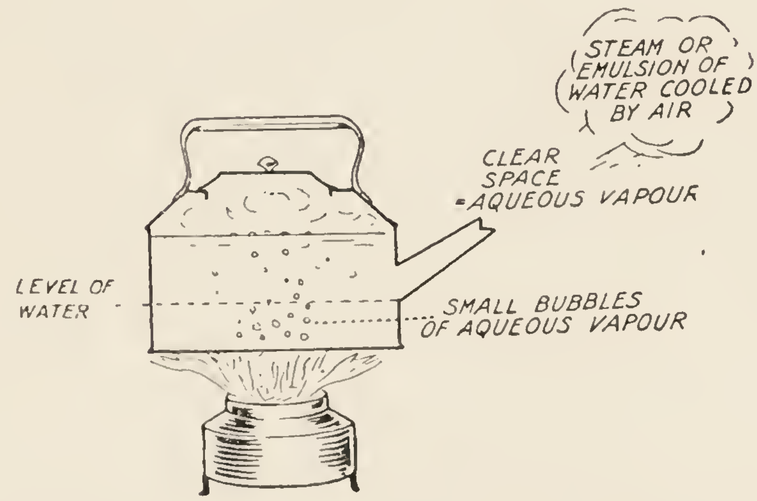


FIG. 5 represents convection of heat from the bottom to the top of a kettle of water by the hot particles floating to the top. The air bubbles, the clear space and the steam will be again referred to on p. 73.

FIG. 6.

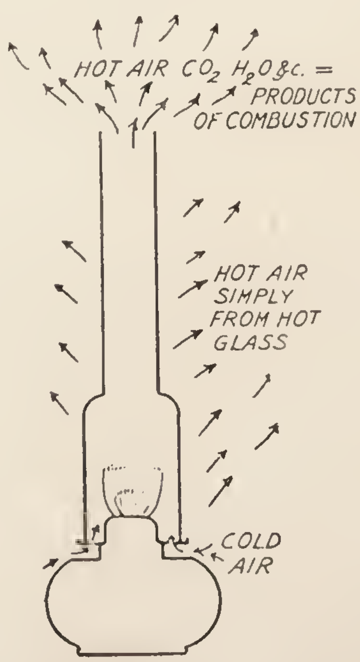


FIG. 6 represents a lamp with hot air going away from it, with a stream of cold air entering at the bottom. For the explanation of the distribution of hot air, *vide* p. 42.

of heat. Let us picture to ourselves the spot at which heat is being applied to a bulk of liquid or

gas—the bottom of a kettle, the flame of a lamp, the hot-water pipe, or an electric heater—the actual

FIG. 7.

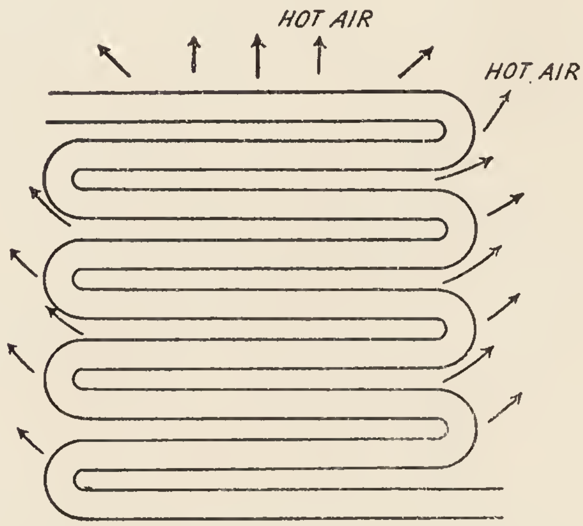


FIG. 7 represents a hot-water (it might be hot aqueous vapour or steam inside the pipe or simply hot air) heating apparatus. The arrows represent hot air rising in all directions from it, thus convecting heat from the pipes as it does from a lamp (*vide* also p. 42).

atoms or molecules of air or liquid nearest to the spot will be set in more active vibration, become

FIG. 8.

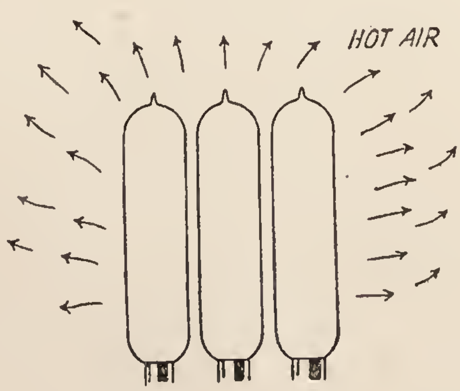


FIG. 8 represents similarly an electric heater with the hot air convecting the heat to the room in exactly the same manner as it does from the hot-water pipes.

lighter (*vide* below, p. 47), and will consequently alter their position by floating to the top of the heavier particles. Obviously, then, a current of warm

water or air sets in towards the top of the containing vessel, kettle, room, etc. On their way to such top the molecules may, and do, lose some heat by simple conduction to their neighbours, but in the long run the heat is carried through the mass by molecular

FIG. 9.

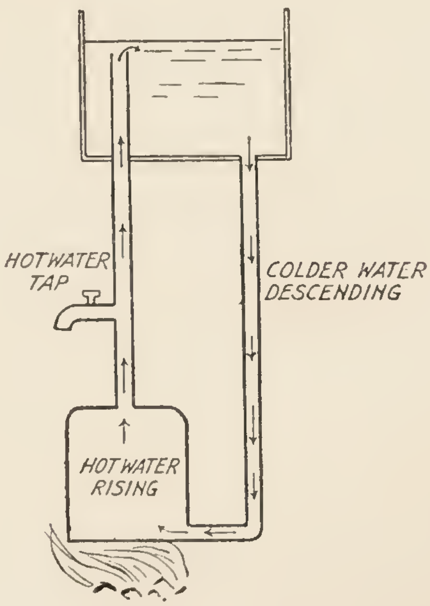


FIG. 9 is a rather more complicated illustration of heat convection from a kitchen boiler. A hot-water pipe heating apparatus, Fig. 7, can be imagined to be attached to a tap similar to that noted as the hot-water tap. Apart from such a special hot-water apparatus the pipe leading up from the hot-water boiler can be lengthened to any extent and carried along passages, etc., to warm them, limited only by the strength of the boiler to stand the pressure of the water.

convection till each particle is as warm as its neighbours.

The poorness of water as a *conductor* of heat is easily illustrated by the fact that a nurse can hold a test-tube in her hand and boil the water in the top of it over a spirit lamp while the bottom of the test-

tube is quite cold, and similarly if she boils it from the bottom she can see small bubbles of aqueous vapour formed at the bottom becoming lost by recondensation as they pass through colder layers above.

Radiation of heat is the passage of heat through space independently of what is in that space, *i. e.* whether it be occupied by air, or a liquid, or a solid, and, indeed, through a vacuum or space empty of all air. Heat is thus radiated from a fire quite independently of the air or other objects round a fireplace. All the heat (remember $-273°$ C. is no heat) that every natural dead object possesses is heat radiated from the sun through space and our atmosphere. It is a somewhat difficult subject to appreciate, and we may leave it with just a few examples from domestic hygiene.

Dark-coloured objects absorb more radiant heat than light-coloured ones, hence the reason for wearing light dress colours in summer and darker ones in winter to regulate the absorption of radiant sun heat. Blackened saucepans in *front* of a fire will absorb more radiant heat from the fire than bright ones and so keep food warmer. Metal hot water jugs and tea-pots, etc., should be bright, as they thus retain heat better, *i. e.* do not radiate it so rapidly.

WHAT HEAT DOES.

Heat being by our definition molecular vibration, it is easy to follow what happens when we add to this movement, or warm a thing; obviously we produce

a tendency for the molecules to separate more widely from one another.

Under moderate degrees of heat with all gases and with most liquids and solids this is all that happens, and the result is a simple physical expansion of the substance heated, provided the liquid or solid be prevented from assuming a gaseous condition by pressure or by its intrinsic physical condition.

India-rubber, and ice or water between 0° C. and 4° C. (32° F. and 39·2° F.) are curious exceptions, the former of no interest to domestic hygiene, the latter of profound interest (*vide* p. 93); of course, also, wet clothes, ropes, and fresh parts of plants under heat dry and shrivel up, but these are instances of a mere loss of water and are only apparent exceptions to the rule.

The further result, that things by this expansion become lighter, requires a word of explanation. Take a box, each side of which is one inch, so that we have an object measuring a cubic inch. Let the box be filled with air, or water, or iron. Now let us warm the box. The expansion does not mean that our cubic inch box will weigh less when warm than when cold; it means this—that the cubic inch of air, of water, or of iron, will when warm, occupy more room than when it is cold; if the difference is great enough it will burst the box and run over, so to speak, and hence if we weigh an exact cubic inch at the higher temperature it will weigh less than an exact cubic inch at the lower temperature by just so much as would have run over when the cubic inch

at the lower temperature was made by heat to expand to the greater bulk.

Now increase the heat still further so that this mere tendency of the atoms and molecules to separate becomes an accomplished fact. The heat required to effect this purpose, either for gases, for liquids, or for solids, varies enormously, from -250°C. or thereabouts for most of our so-called permanent gases, through 100° C. or 212° F. for the boiling of water, and conversion into aqueous vapour, up to somewhere about 5000° C. for some of the materials out of which fire-bricks are manufactured (*vide* pp. 34, 51).

We are now introduced to a set of extremely varied results—some physical and some chemical—due to the fact that the substance heated will try to assume the lightest possible shape it can take. Gases are the lightest things with which we are acquainted, and as a matter of fact all liquids and solids can by heat be made to assume the condition of a gas or vapour (*vide* p. 21), but in so doing they, or rather their constituent atoms and molecules, are frequently compelled to undergo fresh chemical combinations. Liquids commonly change straight into a vapour; solids commonly go through a change of melting into a liquid state first and then pass into a vapour. If during this process of heating there is a free supply of oxygen available the products resulting will very commonly combine with the available oxygen, or burn, in common language, and thus change into vapour. If oxygen be not thus available they will still vaporise, but not as oxides. Lastly, if the resultant vapours, whether oxidised or not, are not natural gases, *i.e.* chemical compounds or elements which have a gaseous form at ordinary air temperatures, then as the heat leaves them they will cool back again into their natural condition, *i.e.* into the form, liquid or solid, in which they naturally exist at ordinary air temperatures.

A complete exposition and explanation of these effects of heat is a very complex, difficult, and highly technical subject, and I should not have introduced it at all except for the fact that it explains a very great number of incidents in domestic hygiene which may now be introduced.

ILLUSTRATIONS OF SIMPLE EXPANSION.

Of gases.—This expansion by heat explains the rising of hot air to the top of a room, or at least to a cooler level in the room (*vide* also p. 140); the bursting of a closed bottle by expansion of air inside when placed near the fire is another illustration.

There is an important law to be considered in connection with this simple expansion of gases under heat. The law itself is this: The strength of the current of air or draught thus produced by the expansion of the warmed air is directly dependent upon the degree of heat which is causing it; the application of the law or its importance in domestic hygiene is that it explains a "smoky chimney," that is, the return of smoke down a chimney into a living room. Thus the heat of the fire causes the draught up the chimney. The hotter the fire, *i.e.* the more brightly and strongly it is burning, the stronger is this draught (the less smoke also, *vide* p. 51, will there be), and the more likely therefore it is to overcome any down-draught caused by the wind down a chimney; hence a good, hot, bright fire is sometimes a cure for a smoky chimney. It may interest the

reader to know that this draught up a chimney is also dependent on the height of the chimney. This explains the tall chimneys of factories; moreover, it explains why a bedroom chimney sometimes smokes when the chimneys lower down in the house do not smoke.

Of liquids.—Expansion by heat explains the boiling over of a saucepan that has been filled too full before being placed on the fire. There is not only the bubbling of boiling which helps, but also the expansion of the water or milk, etc., till it overfills the saucepan. It explains the circulation through a hot-water system by the rising of the lighter hot water to the top, *vide* Fig. 9, p. 45.

Of solids.—Expansion by heat explains the cracking of glass tumblers, bottles, etc., when very hot water is poured into them. The inside is heated, it is unable to conduct the heat with sufficient rapidity to the whole thickness, so the expanded inside is too big for the cooler outside and cracks or breaks it. The loosening of a glass stopper in a bottle by warming the neck of the bottle is the same phenomenon, but now the outside expands and the stopper becomes loose. The cracking of pie-dishes, etc., in a very hot oven is frequently due to the same cause, viz. unequal expansion of the material too great to be resisted by the structure of the dish.

The structure and the thinness of test-tubes permitting of rapid conduction is the reason why we can actually boil water in them over a lamp.

EFFECT UPON COAL, WOOD, AND OIL (FUEL).

The heat of the fire or match flame causes volatile organic compounds to issue from the coal, wood, or oil (fuel of all kinds). If, now, the heat at the point of issue is great enough and the supply of oxygen free enough, these compounds burn or oxidise with a nice, clear, bright flame, giving out a great amount of radiant heat to the room ; if, on the other hand, the heat is not great enough, or if there is not plenty of oxygen, these compounds appear as smoke, which may be defined as the unburnt gaseous products of heated fuel ; the smoke goes up the chimney, is there cooled, and these compounds, not being permanent gases, condense back into soot, which may therefore be epigrammatically defined as solidified smoke.

The lesson to be learnt is this : If you want a clear, bright fire, put your coal on little by little, so that the fresh coal may not cool the fire too much nor prevent the access of plenty of air. The use of the bellows to drive more oxygen into a fire is explained by the same laws, as is also the caution not to use them too freely at first lest you cool your glowing spark too much with cold air. Poking a fire, raking out ashes which block the entrance of air, or lifting up the coal or breaking it into small pieces is another means of letting oxygen gain access to a fire.

The manufacture of coal-gas is carried on by just the effect of heat on coal in the absence of oxygen, so that the volatile products cannot burn until a supply of oxygen is provided at the outlet of the gas-burner ;

the same absence of oxygen explains the fact that gasometers do not explode when a gas-jet coming from them is lighted at its exit.

SCORCHING OF CLOTHES, ETC.

This is precisely the same thing: the heat is sufficient to cause the material to emit the same, or rather, similar volatile organic compounds; these we perceive as the smell of scorching, and if we are not quick the clothes will then catch fire and burn. The brown colour of scorched clothes is little else than carbon or charcoal unoxidised, because the heat was not great enough. The same laws explain why a damp cloth does not scorch; the heat causes the water to evaporate because water is more volatile than the material of the cloth, and not till the heat has driven off all the water can it attack the material to scorch it, because the heat is first used in boiling off the water.

Charring is a further stage of the same process. The two stages are well seen and contrasted in the nice browning of bread and pastry crusts, a burnt crust being one that is charred, *i.e.*, reduced merely to carbon.

COOKING.

It will probably be unknown to most beginners that most cooking should be done at temperatures ranging about 60° to 80° C., or 140° to 176° F.; between these limits many volatile organic compounds are given off from meat and constitute the pleasant smell of good cooking (*vide* p. 158).

PHYSICS OF LIGHT.

INASMUCH as no inconsiderable part of a nurse's time in the sick room is occupied in work which involves clear vision, it is obvious that lighting conditions come well within a nurse's purview.

The fundamental point to raise or question to ask is, What is the best light for ordinary purposes, excluding photography, microscopy, etc., but particularly including reading, sewing, etc.? Now to this there is only one possible answer, viz. diffused daylight. It is well to explain the word "diffused" because it has to be contrasted with "direct."

Without entering into any technical details of wave-lengths, undulatory theories, etc., we may compare light to water in this respect: that it travels in a straight line through space—the air so far as we are now concerned—from its source, the sun, a candle, gas lamp, etc., until one of two things happens: (1) It meets with an object through which it cannot pass, hence called "opaque" or totally non-translucent, but from which it is deflected or thrown off at an angle or reflected; or (2) it meets with a substance through which it can pass, but as this second substance is of different density, *e.g.* water or glass compared with air, the light gets deflected or bent out of its path, and we may just put in a paragraph or two as to what happens in the two cases, because they will explain many little details in the physiology or hygiene of lighting, and also many little interesting phenomena in a nurse's everyday life.

(1) **Light strikes an opaque object.**—What does a stream of water do when it strikes the wall? Some of it wets the wall and soaks in more or less, some of it bounces back off the wall at all sorts of angles. Just exactly the same does light do: some of it is absorbed by the opaque body, some of it is splashed off at all sorts of angles; this is known as reflected light, and it is this reflected light (or rather variations in it) striking our eye that enables us to see an object of any degree of opacity.

The meaning of diffused light can now be appreciated: it is light reflected from every conceivable object in the air, on the earth, or in a room, and generally mixed up in a gentle whole.

Continue the analogy with a stream of water: the wall may be damaged by the strong stream directly striking it, but the small streams at diminished velocity refresh the flowers (light has no weight, so velocity may be neglected). Just so the eye; a strong direct light is apt to damage the eye (microscopists often suffer from working too long with strong light), but the small streams of reflected light of different colours rest the eye and give it gentle stimulation.

What hygienic or physiological deduction can we, then, make from this? Obviously this—that to read or sew, etc., most comfortably and with least risk to the eyes, we should always have the source of light obliquely behind us so that the object we are working on should be illuminated by direct rays, but that these should not strike the eye directly (we have

already explained that all objects are visible by reflected rays). Hence we see at once the very great advantage of a movable light; we can place it at the most convenient angle behind our shoulders. If the source of light is fixed, then our seat must be moved till our shoulder is towards the light, our eyes away from it; if the light and the seat do not permit or these relative positions we work at a great disadvantage to our eyes.

Instead of the nurse, who can generally shift her position within limits, take the patient who can't, but who is well enough to wish to read; obviously if his bed is opposite to a window so that he can, when sitting up, see the view out of the window, if he wants to read he will have the direct light striking his eyes and the book in the shadow. Paper is more or less opaque, and an ordinary book very much more than less; hence, if he is to see the view and also to read, some little plan must be put into execution of so arranging a looking-glass as to reflect the light on to his book (a plan nurses will see adopted often enough in hospital wards), unless, indeed, his bed can be so arranged that a side window will give him sufficient light on his book.

(2) **Light strikes a Translucent Object.**—This refraction of light, as it is called, is of no hygienic interest particularly, but it explains why a stick looks bent when plunged into water; it explains the rainbow and all colour vision; it explains the iridescent colours of a thin film of oil on water; but all these are too technical for an elementary book on hygiene.

LIGHT COMPARED WITH HEAT.

Heat and light are both imponderable, *i. e.* neither of them have weight, but the comparison with one another and their analogy with water will enable a nurse to appreciate why dark-coloured clothing is warmer than light-coloured. Heat is in this respect like light, and just as black looks black because it has absorbed practically all light-rays and reflected none, so it is warm because it has similarly absorbed all the heat-rays and reflected none. Again, however, to go any deeper into the matter is too technical for an elementary book.

CONDITIONS FOR A READING LIGHT.

The light should be steady and not flicker, for obviously a flickering light distresses the eyes by the varying intensity which requires a corresponding demand upon the adaptive mechanisms of the eye as an optical instrument for accurate and exact vision.

It should not be too bright, for brightness tires the retina more than a simple competence of light.

There is, or are, rather, further scientific conditions as to the colour a light should be, but these need not trouble a nurse, except to remember that a piece of green or blue shading material will often be found most useful, green being the most restful colour for the eyes.

LIGHTING A ROOM.

Coming more to the practical details of lighting a room, we have already said sufficient about natural or diffused daylight; the artificial means are gas, lamps, candles, electric light, and firelight, on each of which we may say a word, because often enough it may be

in the power of a nurse either to arrange the lights or to make suggestions for their arrangement to suit the exigencies of her nursing situation.

Of **firelight** we need say little. The situation of the source of light makes it almost impossible to read by, not to mention the flickering nature of it; it is pleasant enough to sit and chat by, but need not be further considered; it may be used just for a temporary glimpse at a note, to see the time by, etc., but that is all.

Lamps, candles, and gas in one particular have to be lumped together, viz. that in all of them the source of the light is the burning or rapid oxidation of something (oil, fat, wax, or coal-gas); this to an extent, it is true, diminishes the oxygen available for nurse and her patient, but this is not the real reason of their objectionable qualities as lighters. No; the objection to them is that the products of this combustion (CO_2 H_2O, possibly a minute fraction of CO, and certainly a considerable amount of other unpleasant results of incomplete combustion) escape into the room and mingle with the air of it, instead of passing up a chimney *out* of the room. If there were flues provided over the source of light to carry these products out of the room, they would be unobjectionable in this respect, and even as it is these products (*vide* under "Heating," Fig. 6, p. 43) in a decent sized (*vide* p. 133) and decently ventilated room are probably of more theoretical than practical importance.

(1) Lamps, candles, and an *ordinary* gas-jet are probably all nearly on a par of badness or goodness in the oxygen used and the waste products formed, including heat (which may or may not be wanted) per candle-power[1] of light available for use ; but the modern use of gas (petrol is thus used, a 1 per cent. mixture of its vapour with air, but this requires special burners) with a **mantle** is a very different matter, for here a small quantity of coal-gas is very completely burnt, causing in turn a great deal of heat which heats the mantle to a bright glow, and it is this bright glow which forms the light.

Hence, so far as not polluting the air of the room is concerned, the gas mantle stands far ahead of the others mentioned above.

Its disadvantage against the others is that there is no means of regulating the amount of light and heat ; it is all or none, of both, with mantles ; the other three, lamps, candles, or ordinary gas jet, may be turned up or down or fewer candles used according to the light wanted. Moreover, mantles are very delicate things and easily break.

Electric light.—Barring the expense, with which a nurse has nothing to do, there can be no doubt but that the electric light is the best of all artificial lights for the sick-room.

(1) It does not pollute the air with soot or gases (an electric light is a piece of material—carbon or

[1] Candle-power is merely a standard for comparing lights, just as ounces or grammes, etc., are used for weight.

metallic filament—heated to a glow in a closed chamber, the lamp containing either very nearly nothing, or a gas other than oxygen and incapable of combining with the glowing filament).

(2) It is, or can be made, movable about a room by means of wall-plugs and lengths of wire, and so can be brought behind a screen, set on a table, chair, etc., laid on the floor without spilling oil or grease.

(3) It cannot smell offensively.

(4) It can be shaded perhaps more easily than any other light with a shape and colour of shade to suit anybody and everybody.

(5) By small lamps and small candle-power it can be regulated to any extent in brilliance.

(6) Electric lamps certainly give less trouble than any other light, such as filling oil tanks, cleaning lamps and candlesticks, carrying matches or lighters.

(7) As regards dangers (from fuses blowing out and short-circuit fires arising therefrom, and shock from the current itself), electric lamps are probably superior to any other form of light, though it must be admitted that such accidents are not very infrequent; still, neither are accidents with lamps and candles.

PHYSICS OF AIR.

THESE bulk very largely in all problems of ventilation, and must be dealt with in some detail.

AIR HAS WEIGHT.

This fundamental conception of air as a material or substance with weight is at the bottom of most ventilating problems; it is usually expressed by saying that the pressure of the atmosphere is equal to about 15 pounds on the square inch, the meaning of which is that the weight of a column of air a square inch in section, and reaching to the top of the atmosphere, would be 15 pounds. The reason we are unconscious of this pressure on our bodies is because there is the same pressure inside us as outside us.

The pressure, as a matter of fact, varies a little at different times and in various places according as the atmosphere is a little shallower over a given place, or as we ascend a mountain so as to get nearer the surface of the atmosphere. These variations are measured by an instrument known as the barometer (aneroid or mercurial), which is a common

piece of domestic furniture, and the height of the barometer at any given time and place is an accurate measurement of the weight of the air over the place at that time.

The interest of this fact lies in this, that the height of the barometer has a good dealt to do with the strength and direction of the wind that is likely to be met with in and about a given place, and also with the probabilities of whether rain will occur or not, thus enabling one to judge how to dress for a walk. The exact relationships between the height of the barometer and the weather have puzzled weather prophets for years, and seem likely to do so, but it may fairly be said that a jumpy or changing barometer is commonly associated with jumpy and changeable weather, and a steady barometer with steady weather, either good or bad; a rising barometer suggests better weather and a falling one bad weather.

The height of the barometer influences the temperature at which water will boil (*vide* p. 70).

AIR IN MOTION HAS MOMENTUM.

This is a simple corollary to the law that air has weight, for momentum or force of motion is merely weight multiplied by speed or velocity. This sounds very scientific and complicated, but a few examples will make it easy to comprehend.

The simplest illustration from a nurse's daily life is that of the assistance or hindrance she gets when

walking or bicycling, say, with or against a wind, which is nothing more or less than the momentum of the wind with or against her. The blowing down of trees, chimney-pots, etc., are other familiar examples, as are the sweeping of papers off a table in front of an open window and the blowing about of curtains, etc., in the room.

The direction of this force is worth noting, viz. that it continues its original direction in a straight line until it is turned aside by some physical obstacle. This explains the constancy of a wind at sea and its variability on land, bent out of its course by buildings, trees, etc., and also the places in a room where draughts are felt, viz. in lines going straight from entrance (door, window, cracks, etc.) towards the fire-place or point of exit (*vide* figure of fire on p. 141).

Let us now try to go a step farther in this physical law and explain the difference between a wind, a draught, and fresh ventilation without either a wind or a draught.

These three things all depend on weight and velocity—on momentum, in fact—but as it is not quite easy to appreciate these points in air, which we cannot see, let us take a stream of water, which we can see and appreciate, to try and make matters clear.

Suppose a person stands, first of all, in a stream of water up, say, to his neck, it is very easily appreciated that if the stream be flowing very rapidly he will be washed off his legs by the weight and

velocity of the water; if it be flowing only very gently he is easily able to stand or even walk up stream. This is absolutely identical with being in a wind so far as mechanical effects are concerned.

Now, suppose instead of being in a stream he stands opposite a pipe of water, say a garden-hose (the garden-hose is a very small pipe, but we can imagine it enlarged to any extent), the stream of water here corresponds exactly to a draught, and just as the actual bulk of water striking him is now not nearly so great as in the brook, so the momentum (bulk or weight multiplied by velocity) will not be so great, and may not knock him over unless a pretty large pipe and great velocity of the water be used; so a draught does not produce much mechanical effect, though its physiological one may be great (*vide* p. 110).

Lastly, **free ventilation without a draught.**—We may now take the garden hose and try to water a single plant with it. If the hose be directed straight at the plant or straight at its root it will either knock the plant over or wash away all the earth from its roots, neither of which results is what we want. What do we do? We may either direct the hose on to a wall and let the water bounce off in the form of a spray, or we may put a top on the end of the hose with tiny perforations in it (a so-called rose-top). In either case the velocity of the water is much diminished, but more important still, its bulk is broken up into hundreds of smaller, quite

tiny streams, so that its momentum is almost entirely destroyed, and it falls almost imperceptibly on leaves or root, and so refreshes without doing any harm. This is exactly what happens when fresh air strikes a wall, a ceiling, or artificial obstacles at inlet (this is the principle of the so-called Plenum system of artificial ventilation—the rose of the hose): it is broken up in bulk and diminished in velocity, and falls as a gentle, imperceptible shower of fresh air round the patient without blowing him out of bed or causing the unpleasant sensation of a draught.

As regards the figures of these illustrations we may, as a matter of interest, state that when air is moving about 1 to $1\frac{1}{2}$ miles an hour we call it a still day; that anything from 6 or 8 to 10 or 12 miles per hour is a breeze; that hurricanes and storms may go anything from 60 or 70 to 100 miles an hour; and lastly, that small currents must be moving at over $1\frac{1}{2}$ miles per hour at 55° F. for them to be perceived.

AIR WHEN HEATED WILL BECOME LIGHTER.

This we have already considered in the abstract under the heading of "Heat," remembering that air is merely a gas, or rather, mixture of gases. We have now to consider what effect this will have in the place or room where it occurs.

The air which is lighter must obviously rise, owing to the action of gravity, and thus a current of air or draught must be produced ascending from the source of heat, but as the warm air flows away, something must take its place—the something being colder air. Apply this law to a fireplace, candle, lamp,

gas-flame, hot-water pipe, electric lamp, etc., *vide* figs. on p. 44, all of which are sources of heat used to warm a room: every one of these produces precisely the same effect, in the shape of a current of hot air upwards, or, at least, away from the source of heat, and a current of cold air towards it, but they certainly differ, and differ markedly, in the strength and also in the direction of these currents, and so differ as means of warming a room equally all over as well as the persons in the room nicely and comfortably, *vide* p. 139.

It is simply this law and nothing else which is the real cause of winds all over the earth. What happens in a room happens on a larger scale in the open; that is all the difference. Natural ventilation depends on these winds, artificial depends on some pumping apparatus or heat inlets and outlets for the air (*vide* p. 130).

AIR AND HEAT.

A deduction to be made from this rising tendency of hot air is that, speakingly broadly and generally, the exits for air should be at the top of a room and the inlets lower down. When these inlets are more or less artificial—windows, perforated bricks or more complicated contrivances—this can generally be managed, but when air makes its way into a room under the bottom of a closed door and makes for a fireplace, stove, etc., it must not be forgotten that a cold draught is produced along the floor about the level of our feet—a source of cold feet not always appreciated, and one to be avoided by foot-stools or by warm, rather thick, foot-gear.

It is easy to see how, on a hot summer's day, with the temperature outside higher than inside the room, these rules about inlets and outlets may be altogether mixed up, so long as vèntilation is natural and not artificial.

DIFFUSION OF GASES.

The law known as that of diffusion of gases is simply stating as a law the fact that when different gases come in contact with one another they will not remain distinct, but will mix with one another, and the more rapidly the hotter any of them may be. The law is a very simple deduction from the definition of a gas (p. 21). In dealing thus with gases which are invisible it is perhaps a little difficult for a nurse to appreciate this law, though the odours of distant flowers is a simple, easily appreciable illustration, but let her take, say, a tumbler half full of water, and on top of the water place a piece of thin tissue paper with a thin thread attached, then let her carefully pour on to the paper some other watery liquid which is coloured, and then by the thread very gently remove the paper. At first the coloured and the colourless water layers will remain nearly separate, but in a very short time (the time is dependent on laws she need not worry about) they will completely mix ; gases mix much more quickly, that is all.

WATER.

The natural history and physics of water are very interesting, and bulk so largely in both public and personal hygiene that we must devote some space to a consideration of them.

Let us start with a body of water—garden tub, pond, lake, river, spring, or sea—and follow its life-history back to the same spot again, exposed, as it is, to air and the heat of the sun. Of course water can be prevented from evaporating by covering it completely with something impervious to water, but such covering is not present under ordinary circumstances in everyday life. It evaporates or is converted into an invisible gas known as aqueous vapour (*vide* p. 21); this mixes with the air and so diffuses into the atmosphere; in the atmosphere it gets cooled, and as a result the aqueous vapour is re-converted into water, falls in some form or other to earth, trickles over and through the soil, dissolving soluble matter both in its passage through the air and through the earth. Some of it is once more evaporated into aqueous vapour at once, leaving behind it the matter it had dissolved. Some is drunk by the plants and animals growing in and on the earth.

Some trickles on to refill the pond, or brook, or sea, while some continues to sink into the earth until it meets with an impervious layer of matter which thus holds it in an underground lake, the overflow of which forms a spring again. In this journey from water through vapour to water again, water performs many of Nature's wonders, and we must now consider those details of the wonders which have a bearing on our present subject.

(1) *Evaporation is always going on in given suitable conditions.*—This is simply a law of nearly all liquids (*vide* p. 22). It is easy to appreciate in the case of a drop spilled on the table or floor, which speedily dries up, it is also easily appreciable in the case of small shallow ponds and brooks, but we must remember that precisely the same process is going on in rivers, lakes, and seas, though the effect in lowering the level of these bodies of water may require instruments of precision to prove, it can hardly be perceived by the naked eye except in dry weather. For its application to sweat, *vide* p. 100.

(2) *The conditions for evaporation.*—The hotter the atmosphere to which the water is exposed the more aqueous vapour it can hold and the more rapidly does evaporation take place. Again, the less the pressure to which the atmosphere is exposed the more aqueous vapour can it hold and the more rapidly will evaporation take place. Further, when a given atmosphere of exposure (*vide* p. 162) contains as much aqueous vapour as it will hold for a given temperature

and pressure, it is said to be saturated with aqueous vapour for that temperature and pressure; evaporation into it then ceases until its temperature is increased or its pressure reduced. These conditions are somewhat complicated for a beginner, and we would not introduce them except for one very important point in hygiene, viz. that they explain the difference in one's personal feelings of health when we are working on a dry, bright, hot day, or on a damp, hot day, on a bright, frosty day, or on a dull, cold, rainy day, the difference depending on the degree of saturation of the air with aqueous vapour, which in turn helps or hinders the escape of moisture from our bodies *viâ* skin and lungs. It explains a great deal of the discomfort of the tropics, where the air is more frequently saturated with aqueous vapour than in more moderate climates (*vide* p. 163).

As a matter of fact it is (in England at any rate) extremely rare for the atmosphere to be saturated with moisture, which is why clothes are hung out of doors to dry, and of course in the domestic drying closet or room there is a continual current of hot, dry air being admitted with rapid escape of aqueous vapour at the outlets.

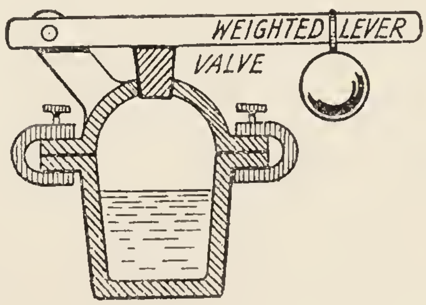
N.B.—If the drying room or closet be allowed to cool the aqueous vapour may be re-deposited (*vide* p. 67).

This rule about evaporation under conditions of temperature and pressure is one of universal application to all liquids, though it is in the case of water that its hygienic interest lies. We

must just pursue it a little farther, because its extension explains the meaning of forced stewing in the kitchen and the difficulties of boiling an egg on a mountain expedition. For the sake of clearness we will deal separately with the atmosphere to which the water is exposed and the water itself.

Conditions of the Atmosphere.—To understand the influence of pressure on atmosphere compare it to a sponge. The more one squeezes a sponge the less water will it hold, which gives us an idea of pressure preventing the atmosphere taking up so much aqueous vapour. To understand the condition of heat remember the expansion of gases under heat; this gives us an idea of a hot atmosphere holding more aqueous vapour.

Fig. 10.



Conditions of the Water.—We have stated that all matter, as we know it, contains some heat (*vide* p. 33). This heat will, and does, gradually compel the water to assume a condition of vapour until the atmosphere is saturated. Now increase the heat of the water, and it will more rapidly and forcibly convert itself into vapour, in spite of the pressure of the atmosphere which tries to prevent this. As the heat increases the force of evaporation will get greater and greater until the water will evaporate, no matter what the natural pressure of the atmosphere may be. The temperature at which this happens is known as the boiling point of water (all liquids have a boiling-point, fats have one much higher than water) for that particular pressure. When water is boiled in an ordinary way in a kettle this temperature is 212° F. = 100° C. (within a small fraction), and the pressure of the atmosphere is 15 lb. to the square inch (*vide* p. 60). Within the limits of a few hundred (each 600 feet makes a difference of a whole degree Fahrenheit) feet above or below sea-level this

temperature is not interfered with for domestic purposes, but if we take an egg to the top of a really high mountain we shall find a difficulty in boiling it, *i.e.* water "boils" there at too low a temperature to coagulate the egg in the regulation three and a half minutes, and on the other hand if we want to make water hotter than 212° F. (to extract the best material out of bones) we must by some artificial means increase the pressure of its atmosphere. This is done by a stew-pot with a screw lid and with a safety valve on it, as in Papin's digester (Fig. 10).

The air over the water in the stew-pot is its atmosphere; the screwed-on top and the safety valve prevent the air from escaping till the pressure is raised above that which the valve and pot are built for. By this means the temperature to which the water can be raised is limited only by the strength of the stew-pot.

(3) *Evaporation of water is always associated with a disappearance of heat.*—Here, again, we are dealing with a general law of matter and heat (*vide* p. 46), with a special interest in the case of water, in that water is the absolutely commonest cooling agent, and that, bulk for bulk, water, in its evaporation, causes more loss of, or uses up more, heat than any other substance.

The scientific explanation is that the heat is used up—*i.e.* it is no longer appreciable as heat, it becomes latent as it is termed—in keeping the water in a state of vapour.

The heat thus made latent is abstracted from all surrounding objects, including the water which is being evaporated.

So many examples of this use of water occur in our domestic life it is difficult to know which to choose; perhaps the most significant are:

(*a*) Putting out a fire by pouring water on it.

(*b*) Sprinkling the floor of a room to cool the air; throwing water on the glass sides of a greenhouse.

(*c*) Keeping drinking water in unglazed pots, through which the water gradually makes its way, evaporating on the outside and so keeping the water inside nice and cool for drinking.

(*d*) The physiology of the loss of heat from the body by means of sweat from the skin and by the respiration is entirely and absolutely governed by this law; the heat required is gained entirely from the body (*vide* 100).

(*e*) The placing of wet rags on a patient's head to cool it.

(*f*) By this law is explained the fact that we can stop in the hot chamber of a Turkish bath (much above the temperature of the body) without harm, provided we sweat and breathe freely, but not otherwise.

(*g*) Ice can be and is made artificially by the evaporation of certain liquids.

(4) *The aqueous vapour, or at least the air containing it, is cooled, and the vapour recondenses into water.*—The cooling is merely an instance of the law that heat will always escape from the hotter body to a cooler one (the upper air is always cooler than that nearer to the earth, and the general atmosphere is generally cooler than our bodies or other ordinary source of domestic heat), and as the heat has merely been occupied in holding or keeping the water in a state

of vapour, obviously when it escapes the vapour has to recondense into water.

This condensation on cooling is the explanation of many natural phenomena both in the weather and in personal hygiene and physiology.

(*a*) White clouds or white mist and steam are all identical in composition, and are simply emulsions (*vide* p. 23) of water in air, *i. e.* the aqueous vapour has condensed into very fine microscopic droplets of water which for a time remain suspended in the air.

The phenomena to be observed when a kettle is boiling, when we are breathing heavily in cold, frosty air, when a horse has exerted himself heavily on a cold winter's day, are all excellent illustrations taken from everyday life of this difference between aqueous vapour and steam; close to the kettle spout, or our mouths, or a horse's mouth and skin nothing can be seen; the water is in a state of vapour (being hot enough for the purpose); a few inches, or rather further away, a cloud of steam or emulsion of water appears from the cooling of the vapour (*vide* Fig. 5 on p. 43 of a boiling kettle).

(*b*) Rain is merely clouds, or mist, or steam, in which the droplets have collected into larger drops, each individually visible to the naked eye, exactly the same as the moisture that collects on a cool object placed near to any of the objects mentioned above.

(*c*) Snow is frozen steam or mist.

(*d*) Hail is frozen rain.

(*e*) Dew is aqueous vapour condensed on an object out of the air by reason of the object being cooler than the air with which it is in contact.

London or other town fog is mist plus other things, *vide* next paragraph (5).

(5) *Water in the state of water, i. e., mist, rain, etc., not as aqueous vapour, is the simplest and most universal solvent known.*—Hence, either as a cloud and (or) in its passage through the air as rain, water dissolves as much as it can of the constituents of the air through which it is diffused or falls. This accounts for the fact that in the open country, on moors and mountains, where the air consists of practically nothing but oxygen and nitrogen with almost negligible quantities of anything else, rain-water (rain clouds or white mist) is remarkably pure and contains nothing but these gases; in towns, on the other hand, fumes from all sorts of manufacturing processes (HCl, H_2SO_4, HNO_3, etc.), CO_2 from human and animal bodies, soot and dust of all sorts from domestic fires, in fact, impurities of every kind are suspended or diffused in the air and become dissolved or suspended in the rain or mist. Hence the colour of a town fog and the acid reaction and other undesirable qualities in rain-water collected in towns.

Finally, in its passage over and through the surface of the earth, water continues to dissolve what it can of the objects that come in contact with it, and also mechanically carries along with it a good deal of insoluble *débris*.

SOFT AND HARD WATER.

We must here define the terms "soft" and "hard" as applied to water. Water is H_2O, or water and nothing else, but in this state of purity it is only found in the chemical laboratory and so hardly comes into hygiene. In a state of Nature it does, however, exist (rain in the open and white mist), with practically nothing dissolved in it except permanent gases—O, N, or CO_2—and in this state is known as pure soft water. So soon, however, as solids, and particularly mineral solids (*vide* p. 20), begin to be dissolved in it, it changes its character, and we now begin to speak of it as hard, the change from soft to hard being entirely one of degree—it is, as a matter of fact, estimated or measured by an artificial standard of degrees of hardness, which in turn are calculated by the amount of soap required to get rid of the mineral matters—so that a given sample of water may be soft compared with some other sample, but hard compared with a third one.

Now, on lofty mountain tops and slopes which have been washed by rain and mist for countless ages, water is now able to dissolve but little; moreover, it runs off very quickly (*vide* p. 26). Consequently, the water in mountain tarns, lakes, and brooks is very soft, and also even in rivers, ponds, and low-lying lakes, for on its way down it has flowed in such volume as not to allow much of it,

comparatively speaking, to come in contact with beds and banks.

Circumstances, however, go somewhat differently with that water which falls on and soaks into the ground; it continues to dissolve mineral and other matter out of the soil, becoming harder and harder according to the solubility of the material it meets with, until, by the time it has reached a more or less permanent underground home, it is probably very hard.

There are, however, important hygienic differences in the natural history of such water; thus, if the nature of the collecting ground be such that a mere mass of ordinary soil, chiefly vegetable remains, lies on a comparatively superficial layer of rock or clay or other material impervious to water, the soil merely holds the water more or less like a sponge, forming a bog or marsh, the water continually oozing, dropping or running away without having penetrated very far. Such water is called "surface-water," and may form a shallow spring, or brook or pond, or soak into a shallow well, which is merely a hole dug a few feet down to collect such water. In hardness the quality of this surface water will be poor, *i.e.* fairly soft, but its drinking safety will entirely depend upon the nature of the superficial soil and the uses to which this is put, and may be said to be risky and generally undesirable for drinking without proper preparation (*vide* p. 85).

When, on the other hand, the water has soaked

through this superficial layer and probably one or two deeper ones, and has reached the deep underground reservoirs or streams, it is commonly very hard and its drinking qualities safe and desirable. Such streams and reservoirs are tapped by deep wells and artesian borings (*vide* pp. 78 and 85), and they supply deep springs, the superficial exit of which may be a very long way (perhaps miles) from the bulk of water (*vide* p. 68).

FIG. 11.

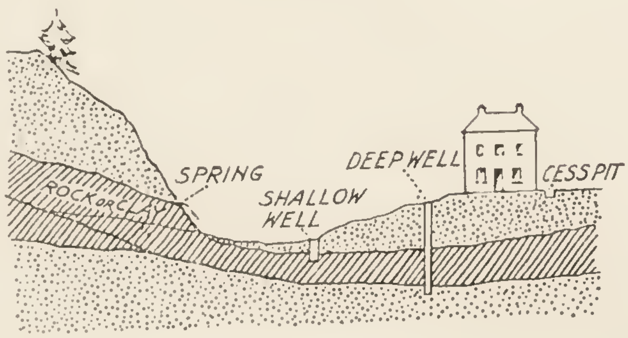


Fig. 11 explains by a picture somewhat diagrammatically the above paragraphs. It shows a shallow well penetrating only through the (dotted) superficial layers of earth, and a deep well penetrating through the (obliquely shaded) deeper layer of rock or clay, also somewhat imperfectly the outbreak of a spring, the underground lake or source of which is not shown; it would be somewhere away on the left of the figure. The cess-pit close to the house (which is bad) is shown resting on and draining into the (dotted) earth above the level of the shallow well; this also is hygienically bad, but illustrates the dangers to which shallow wells are exposed. Inci-

dentally, too, the figure shows the necessity for lining wells, whether shallow or deep, with a lining quite impervious to moisture, otherwise the polluted surface water could soak through. If we imagine the deep well here depicted as an iron tube we get a sufficiently accurate idea of a so-called artesian well.

We can, from this explanation, easily see that shallow springs and wells are very inconstant sources of supply. The deeper sources are much more constant.

As a last interesting physical fact in the natural history of water we may consider how it is that large bodies of water seldom freeze right through. As the water cools down towards freezing point, the colder water, being heavier than that which is warmer, sinks to the bottom. This process goes on till all the water is reduced to a temperature 4° C. (39·2° F.) above freezing. Below this temperature, water, curiously enough, expands, and becomes lighter, or at least ceases to become heavier. Thus the upper part, exposed as it is to a freezing temperature, can sink no more, but cools on till it becomes ice. This explains how fish can live in lakes and ponds without being frozen in.

HYGIENE OF WATER.

We may now proceed to consider the domestic uses of water, the why and wherefore of which are very much dependent upon, and elucidated by, the natural history and physics of that indispensable commodity.

Its uses in personal hygiene are:

(1) For drinking purposes.

(2) For washing the person, clothes, etc.

(3) For flushing and cleansing drains, etc.

(4) Action of skin.

WATER FOR DRINKING PURPOSES.

Two points require notice in this connection :

(*a*) Its quantity.

(*b*) Its quality.

(*a*) *Quantity*.

Some people drink more than others, and require to do so because of the nature of their work, which may entail an enormous difference in the loss of water by skin, lungs and kidney. Contrast the work and habits and requirements of an iron-puddler with those of an office clerk. These differences are explained satisfactorily in the section dealing with the skin and perspiration (*vide* p. 100), and need not further trouble us here. Disregarding such extremes, it may be stated that a comfortable average is about three pints of liquid a day, taken in the actual form of beverages ; it must be remembered in this connection that ordinary so-called solid food contains more than half its weight of water, but this should not interfere with a daily intake of recognised fluid of three pints, for water forms more than half our total body-weight, and as it is constantly escaping from the body so it requires free renewal, for no process can go on in the body without it.

The quantities allowed by water companies to the inhabitants of towns or other places supplied by public service, for all purposes (drinking, washing, flushing), are of the greatest interest and importance to medical officers of health, but the subject

belongs more to public than private hygiene, and it is sufficient to state here that it is commonly estimated at a minimum of thirty gallons per head.

(*b*) *Quality of Drinking-water.*

From a physiological point of view water needs to be water and nothing else, but as we drink it, it practically always contains much besides water. The matters contained in our drinking waters may be dissolved or suspended (*vide* p. 166), and either category may be improving, neutral, or deleterious; they may be gases, liquids, or solids; they may be derived from the animal, vegetable, or mineral kingdom; they may affect the colour, taste, or smell of the water; and lastly, natural water may be too hot or too cold to drink.

To really complete the history of drinking-water one ought to discuss all these points rather fully, but as most of them have so little bearing on a nurse's duties and personal hygiene, I shall content myself with very brief references to most of them, merely giving some common domestic illustrations.

MATTER WHICH IMPROVES WATER.

Let us first clear the ground by stating that all that is wrong with pure distilled water is its insipidity; to say that it is indigestible, unless by its insipidity, is pure and simple nonsense, and to say

that it supplies no building material for the body is equally nonsense, for it supplies water, the most indispensable of all building materials.

First and foremost in the improving matters come the two gases, oxygen and carbonic acid, both of which much improve the taste. Oxygen is absolutely indispensable for all the animal life that is lived in and under water; to us it is, from this source, a matter of taste only, as we derive our oxygen from the air. Carbonic acid is the gas which, dissolved under pressure in water, makes the sparkle or fizz not only of our soda-water, apollinaris, salutaris, etc., but also of a good many natural spring waters, and, in addition, that of all sparkling wines, from champagne to gooseberry, and of all forms of beer, cider, and ales. These gases are improving only, and are absolutely innocuous in any extent found naturally or induced artificially.

In addition to these gases, water is improved and made tasty by the presence in it of small quantities of mineral matter, carbonates, phosphates, and sulphates of calcium (lime), magnesium, sodium, and potassium, but the total quantities of all these salts taken together should not be great, not more, that is, than 8 to 10 grains per gallon, otherwise they have a tendency to become deleterious in themselves, or at least to indicate the presence in the water of something that is, or may be, deleterious; even the smallest trace of lead salts is bad (*vide* p. 8).

Beyond these simple statements we cannot go

without wandering far too deeply into the province of the medical officer of health.

SUBSTANCES FOUND IN DRINKING WATER REQUIRING CAUTION.

(1) *Inorganic salts.*—As we have seen, these in small quantity are good and tasty; whether they remain good or neutral or become harmful is more a matter of quantity than of quality in most cases, and in what we may call ordinary spring waters the quantity is always within useful limits. The matter is, however, far otherwise with special (mostly medicinal) springs, of which we may give a few examples, the water of which is distinctly noxious and only to be taken under medical advice. Thus we have:

(*a*) Iron in many so-called ferruginous or iron-containing springs; the water looks and tastes nasty, but probably is not deleterious even in fairly large quantities.

(*b*) Arsenic in certain springs in various parts of the world; certainly dangerous.

(*c*) Magnesium, sulphate and carbonate, in Hunjadi Janos and other advertised medicinal waters; aperient in action, and therefore likely to be deleterious.

(*d*) Hydrogen sulphide in Harrogate waters; abominably filthy to taste, probably useless, and may be deleterious.

(*e*) Sea salts in Woodhall Spa water; certainly nasty, and not of much use.

(*f*) Common salt in the water of Droitwich; nasty, not of much use.

(*g*) Lime in large quantity in the so-called petrifying springs, so much of it is in the water that some crystallises out on the object left in the water.

(2) *Gases other than the average constituents of the air.*—Except for hydrogen sulphide in Harrogate waters (*vide* above), there is not much to be said on this point. Coal-gas from a leaking gas-main, CH_4 or marsh gas from decaying vegetable matter, foul-smelling gases from sewers and sewage matter gaining access to the water are those that require mention. They may possibly cause some symptoms (diarrhœa), but certainly their importance lies much less in any harm they can themselves do when taken into the stomach than in the fact that they are indicators of some defect in pipes or sewers that requires attention, or of some liquid or solid organic deleterious material which has reached the water (*vide* next paragraph). This should be remembered, as nurses are fond of telling me about "bad gases" in water, as though they caused the illness in themselves.

(3) *Organic matter, vegetable or animal.*—(*a*) *Vegetable:* As may easily be anticipated from the natural history of water (above), these are likely to be especially abundant in water from such sources as peat or mountain bogs and other stagnant waters in any district, which sources may possibly be used for drinking water in rural places. In themselves they

are not likely to be very deleterious, though they may probably make the water look and taste nasty.

(*b*) *Animal*: These are the essentially dangerous things in water; yet even here the danger is still not so much from the intrinsic properties for harm of the animal organic remains themselves as from the possibilities of microbes being associated with them (*vide* below). They indicate very obviously, or prove, rather, that animal excretions or sewage and dead remains of man and animals have actually reached the water; if these have, then, so have the microbes. From our natural history of water, it is quite obvious that they will be abundant in surface water of all sorts from farms, etc.; hence such surface waters are risky to drink, for at any time such water may become infected with virulent microbes of disease.

(4) *Microbes.*—Here we reach the real crux of the problem of water contamination and the essential reason of the dangers of organic pollution of drinking-water. Cholera, typhoid, diphtheria, and scarlet fever are the typical diseases that have been known to be thus disseminated, but it is probable that other less destructive diseases may also thus be carried about—dysentery, hill diarrhœa, etc.

(In Egypt and elsewhere in the tropics there is apparently a danger in bathing in water infected with various kinds of worms possessing the power of penetrating the skin as well as entering by the natural orifices of the body.)

(5) *Suspended matter.*—*Vide* how to make water fit for drinking. All microbes in water are essentially suspended, but dead animals and animal matter are the important things.

(6) *Heat.*—In a few places in the world hot springs exist, dangerous to drink from dissolved matter, as well as too hot for comfort.

From all the above it is easy to see that, except for rain-water collected into clean vessels direct from the air (not even this in towns and collected from lead roofs, etc.), there is no natural source of water that is at all times free from suspicion of contamination. Deep wells, springs from deep sources, and water from artesian[1] wells, are almost free under any natural circumstances, but want testing occasionally. Surface water of all kinds, whether as brook, river, pond, lake, well, etc., is always liable to be contaminated by accidental circumstances. After heavy rain such sources are practically certain to be stained with suspended and dissolved matter, and may be rendered deleterious by organic matters of all sorts. But now these sources must be used, or we should soon be very short of water for drinking. So we have now to see

HOW WATER IS MADE FIT FOR DRINKING.

All mankind may be divided from this point of

[1] Artesian wells are nothing in the world but springs made by man instead of Nature. They tap deep underground natural reservoirs of water under pressure, which consequently rises when a boring is made down into it (*vide* Fig. 11, p. 77).

view into two groups—those that are supplied with water by water companies, and those that rely upon local natural sources.

N.B.—It is well to remember that on one's holidays one may be temporarily removed from one class to the other, and the same fate may overtake a nurse in rural nursing.

(*a*) *What Water Companies do.*

This may be very briefly described, as it hardly comes into elementary personal hygiene. In broad general terms it amounts to this: that the water is allowed to stand in large reservoirs (either natural ones such as Loch Katrine, for Glasgow, etc., or artificial ones such as the London water companies use). In a short time the suspended matters sink to the bottom, and the water is very materially purified by aquatic (animal and vegetable) life, and by the oxidising power of air and sunlight. It is then allowed to filter through gravel and sand (some lake supplies hardly require this), and finally it is passed along mains to the service and supply pipes to the houses, and in this transit has occasionally been known to get contaminated with lead. But there can be no doubt that, on the whole, the water supplied by any water company is wholesome to drink; contamination is undergone, if at all, after the water has left the domestic tap.

(*b*) *What Private People can do.*

If they are in the happy position of being able to draw their water *direct from the main*, they had much better do nothing to it except see that it is drawn and placed for use in clean vessels; it is here, in cases of infectious illness, that a nurse's chief responsibilities arise, in seeing that none of the utensils, cups, mugs, glasses, jugs, etc. used in the sick room come in contact with the water that is to be drunk by other members of the household without being thoroughly sterilised, and to see that no unused water (or milk, or other beverage, for that matter) is taken out of the sick-room.

Much more commonly, however, the water is led from the main into a cistern of some shape and size and material. In more comprehensive works on hygiene, many details of the position and construction of such cisterns must be given; here we may content ourselves with stating that it should be made of material not likely to give deleterious qualities to the water should some of it become dissolved, that it should be placed out of the way, and covered with a well-fitting lid to prevent accidental contamination, either from the domestic cat committing suicide in it or from access of dust; finally, it should be cleaned out periodically. With moderate attention to these details, such water is practically as free from undesirable constituents as that from the main.

When we come to consider those who have no

public water service at all, we are face to face with very great practical difficulties. They must have water, and some of them can get it from deep wells or springs of good quality, but only too often the only available supply is one that, either always or at times, lies under deep suspicion of surface contamination of all sorts. Should a nurse be appealed to by her district patients under such circumstances, let her reply: "Your best plan is to boil all drinking water, and pour it, while boiling, into clean vessels; if you cannot do this, because fuel is too expensive, or for other reasons, your next best plan is to pour it into a big tub, let it stand as long as you can, and use the water from the top. Never let the tub get at all empty, except about once a week or a fortnight, when it should be completely emptied and cleaned, and left for some hours in the sunshine empty."

PRIVATE FILTRATION OF WATER.

Of all the plans **not** to be adopted, that of having a domestic filter is the one in the first place. On an ideal plan, with a filter that is thoroughly cleaned every day (taken to pieces for the purpose, and roasted or boiled), it is possible, but only just possible, to imagine that filtration may be of some use, but such ideal conditions do not exist in the very houses and villages where a filter is theoretically required, and one must condemn as dirty, dangerous abominations, domestic filters as used in the ordinary household. There is no such thing as a good domestic

filter that will do its work properly without constant attention; they are all much more likely to make the water rather worse than better. It does not require much ingenuity to see why—the filter catches suspended matter, and then forms a nice ground for the microbes of decomposition, etc., to flourish upon, and our drink has to flow through this ground.

The filter-beds of water companies are very different, but even they require constant attention.

WATER FOR WASHING PURPOSES.

When the object to be obtained is purely and simply to clean the skin there can be no doubt but that hot soft water is best. The reasons are simple:

(1) Hot water is a better solvent than cold of most things found on the skin (*vide* p. 74). Let me repeat, however, that hands can be quite efficiently washed in cold water.

(2) External warmth (of the water) flushes the skin with blood; this leads to an extra secretion of sweat, and this forces out little plugs of dirt from the sweat ducts; not only so, but the warm skin is softer and thus more easily permits sebum to be squeezed out by the pressure of rubbing and scrubbing. All this is usually spoken of as opening the pores of the skin. I suspect the opening is only a figure of speech.

(3) Soft water uses less soap than hard (*vide* p. 75), and the only objection to hard water is its extra-

vagance in soap (to soften water for small domestic purposes, *vide* p. 92).

BATHS AND THEIR TEMPERATURES.

We frequently speak of hot and cold baths and assume that other purposes than mere cleansing are to be obtained by baths, so we may here add a table of the temperatures of baths with their names and objects. Beginning at the bottom or coldest bath :

(1) Cold bath, anything from 32° F. up to, say, 60° F. (or 0° to 16° C.), is spoken of as a very cold bath, and though it will cleanse the hands fairly well with plenty of soap it is an inadvisable complete bath for any but robust adults with good circulations, and should speedily be followed by warm dry clothes, *e.g.* the Christmas-morning swimming race in the Serpentine is fit only for healthy young persons.

Such a bath may be ordered by a doctor and given by a nurse in pyrexial disease, but a nurse would never dream on her own responsibility of giving such a one, and, indeed, unless she finds a temperature of well over 105° F. and the doctor cannot come for some time she would not even use such water to sponge a patient with.

(2) Temperatures from 60° to 75° F. (15° or 16° to 23°–24° C.) are still cold baths and are used more as refreshers than cleansers, but as there is not such a violent contrast between them and body temperature they are safer for young and old for this purpose,

but are not followed by such pleasant reaction as the very cold bath.

Any of these degrees are satisfactory cooling media on a hot day in summer, and may be used by a nurse for limited sponging of a patient on her own responsibility, provided she has first got general instructions from the doctor that she may sponge a patient.

(3) Temperatures from 80° to, say, 93° F. (26°–27° to 34° C.) are tepid baths, quite good for washing hands and face, but as baths in health, most unpleasant owing to the want of contrast in our sensations and to the absence of reaction in the skin; perhaps most useful (and safest) as cooling media in summer after exercise.

In disease they are, I believe, better even than colder baths for sponging when the temperature is not very violent for just the same reasons that they are unpleasant in health.

(4) From 95° to 98° F. (35° to 36° C.) is *par excellence* the temperature to use for washing little babies. For adults it is certainly a warm bath but one without much attraction.

(5) From 98·4° to 102° F. (36° to 39° C.) increased after getting in to 105° F. (40° C.) or higher according to pleasure. This is the temperature for luxurious washing, limited or unlimited. To most it is an unalloyed pleasure, and the only precaution is to take care to be warmly clad after it, as the skin will perspire freely and will be very sensitive to rapid cooling.

N.B.—Whatever holds of washing the hands and face still holds of the body generally, but its effects for good or ill, pleasure or pain, must be multiplied by twenty or so.

TO SOFTEN HARD WATER.

For certain processes in trade and even for washing and other domestic purposes hard water has great disadvantages; for instance, the hard water, *i. e.* in reality the salts in solution in it, may spoil or entirely prevent the formation of the desired trade product; these salts may be deposited out of the water on boiler plates, they get on the inner surface of the tea kettle and even of a teapot, they use a lot of soap, hence it is of great public and even private utility to know how to soften (or in a few exceptional cases to harden) water. Many patent processes have been invented for this purpose with which no nurse need bother herself, but there are two simple little plans she can adopt if she wants a few gallons or pints for her own domestic use, viz. (1) to boil the water. This succeeds in getting rid of a good deal of carbonate of lime, for this is in considerable degree dissolved in water owing to the CO_2 also dissolved in the water, and boiling drives this off, letting the lime fall to the bottom. If she lets this settle and uses the upper clear water she will find this fairly soft. (2) Add a little bicarbonate of soda or lime-water to her water, roughly about half a teaspoonful

to a pint ; this will to some extent effect her purpose (*vide* p. 13 for the formulæ).

Some waters cannot be softened thus by simple processes ; such are termed permanently hard (it is a question of the chemical nature of the hardening salts). If a nurse has such to deal with she must put up with it or boil a kettleful dry and catch the steam in a cold pot—not an easy job without proper apparatus.

WATER FOR FLUSHING DRAINS, ETC.

On this subject we need say nothing beyond the advisability of having it reasonably free from suspended matters. Its other qualities are of no consequence. Sea or river water may quite well be used.

WHEN AND WHY WATER-PIPES BURST IN WINTER.

On p. 78 will be found a statement of the cooling of water explaining how fish can live through winter in ponds, etc., that are frozen over. The bursting of frozen water-pipes is explained by a little fuller detail on the same point.

4° C. or 39·2° F. is known as the critical temperature of water whereat it is at its maximum density. From this point it can be cooled down to 0° C. or 32° F. without freezing or being converted into ice, provided that special precautions are taken ; such are never taken under natural conditions and con-

sequently at 0° C. or 32° F. water becomes ice, and the change from water to ice is accompanied by an expansion of the water—this is why icebergs or small pieces of ice float on water—this expansion exerts enormous pressure on any containing vessel—here the water-pipe—and bursts it in the act of freezing, and the crack becomes apparent when the ice thaws. To prevent pipes from bursting either (1) wrap them up with some bad conductors of heat or protect them by running them underground (the earth is a bad conductor of heat and so protects them from the frost); or (2) keep them empty when not in use in cold weather, *e.g.* at night; or (3) let the taps be opened so that a constant stream of water is kept running; this last method is extravagant in water and will not serve when the cold is very intense, say below zero of the Fahrenheit scale (−17·7° C.).

ELEMENTARY HYGIENE PROPER.

A. The Work of the Skin.
- (a) *Protection.*
- (b) *As a cooling mechanism.*

B. Clothes, Boots and Shoes.

C. Ventilation.
- *The constitution of the air and its impurities.*
- *How much required.*
- *How to get it.*
- *Effects of deficient ventilation.*
- *Bedroom requires special attention.*
- *Ventilation combined with heating.*

D. Lighting a Room.

E. Exercise.

F. Drainage.

G. Infectious Diseases.

HYGIENE OF THE SKIN.

(A) *As a Protective Covering.*

The skin consists of two layers: (1) Known as the cutis vera or dermis, the microscopic characters of which need not trouble us; suffice it to say that it

consists of fibrous and elastic structures, glands, blood-vessels and lymphatics, arranged in such a way as to allow of the utmost freedom of adaptability to a varying shape of the part, with return to what may be termed the ordinary shape when at rest; this property is known as elasticity—the skin is always a little bit on the stretch, which accounts for the gaping of a simple cut. (2) The epidermis (*epi*, upon; *derma*, the skin) consists of many layers of cells, the outer ones of which gradually become more and more hardened and indifferent to small external influences, such as pressure, rubbing, slight knocks, etc., typically illustrated by the hair and nails and the hard, thick skin on the heels; it must be remembered that these hardened cells are in actual contact and continuity with the delicate endings of nerves of sensation, so that even the slightest external influence or stimulus can still be appreciated for any advisable or necessary movement.

It is thus easily seen how admirably adapted is the skin as a primary protective mechanism for the body.

(B) *As a Heat Regulator for the Body.*

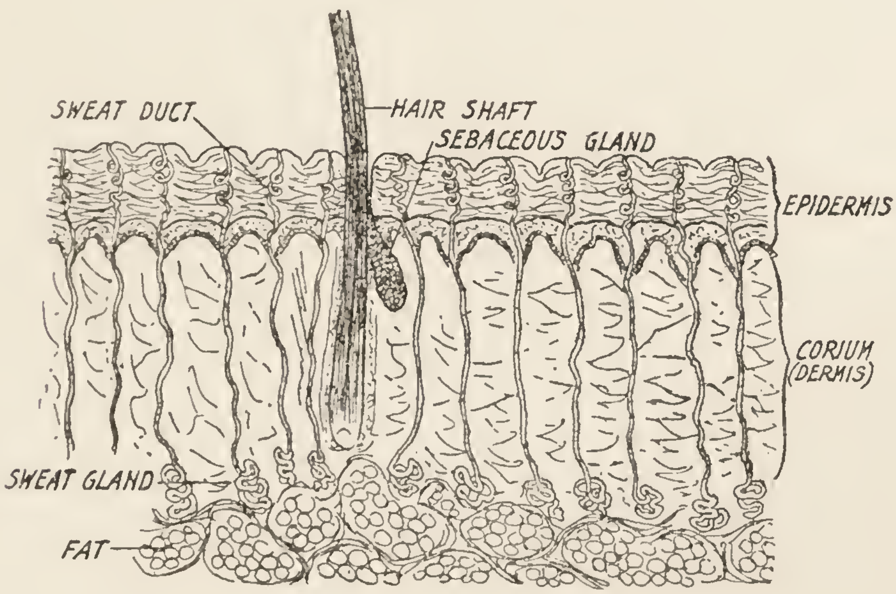
But now the skin has a second and even more important function to perform in the shape of acting as one of the chief regulators of the temperature of the body. The tale of how this happens is as follows:

Fig. 12 is somewhat diagrammatic, but nevertheless fairly accurately represents the essential anatomy

of the skin from the hygienist's point of view. Taking the lettered references as they occur the following points should be noticed :

Sweat-ducts should be noticed running through the epidermis and the true skin down to the small sweat-glands at the bottom, it is their number which is of chief importance (only a few are shown in the figure), and the universality of their distribution.

FIG. 12.



The glands excrete or secrete sweat ; the ducts merely let it run on to the surface of the skin. The sweat provides the watery part of the material found on the skin.

Hair shaft can easily be seen with the naked eye ; the sweat-ducts and glands cannot be so seen.

Sebaceous glands.—These glands, situated always in relation with a hair, have ducts (comparable to those of the sweat-glands, but not shown in the figure) which open on to the surface of the hair-follicle (or little hole from the bottom of which the hair grows). The sebum, as their secretion is called, provides the greasy part of that which is found on the skin, and for the removal of which soap is required.

The Corium need only be referred to, to suggest that the fine lines in the figure may be taken to represent fine capillary blood-

vessels, nerve fibrils, etc., in the corium. They do not get into the epidermis.

Man, as a warm-blooded animal, is characterised by possessing under all circumstances in health a temperature which (with temporary deviations, as in exhaustion after great effort, and which are corrected within, say, an hour) is practically constant at 98·4° F. Now, heat is constantly being made in the body by muscles, glands, etc., mainly by what is probably a process of oxidation, so that if the heat thus made were not as constantly being distributed over the whole body the actual spots at which it is made would soon be unbearably and indeed fatally hot (*vide* p. 10); this distribution is performed by the circulation of the blood and lymph. Again, even so, the distributed heat, if there were no loss, would soon be too great (for details *vide* p. 40), and consequently there are two or three places provided from which heat is lost to the body; the urine and fæces are two such, but quite subsidiary, the lungs constitute one of more importance, but the place of loss *par excellence* is the skin, fully two thirds of the total loss taking place by its means.

Nurses can perform on their own persons a very simple experiment to convince themselves of the importance of the skin as a cooling agent of the body as follows: Get into a hot bath at, say, 101° F., and rapidly add hot water to heat the bath up to 106 or 108° F. Then let the experimenter sink the body entirely in the water, with just the face out; she will find in a minute or less that she is breathing very rapidly. Let her then get a clinical thermometer and take her own temperature either in the mouth

or rectum, and she will be surprised, but let her not be alarmed, to find that it is probably 102° or even 103° F., but it will rapidly fall to 98·4° F.

The heat of the water, being greater than that of the body, not only prevents any skin loss, but even adds heat to the body (*vide* p. 27), and so quickened breathing comes on to get rid of the excess. In a dog's skin there are no sweat-glands, and his panting after a run is mainly for the purpose of getting rid of superfluous heat.

This loss of heat through the skin occurs by three methods: (1) radiation into the air, between the skin and the clothes, and in the meshes of the material of the clothes; (2) conduction through the material itself; (3) through the perspiration, partly by convection, but chiefly owing to the evaporation of the water of the perspiration: each of these methods must be explained.

Through the Air.—Between the skin and the clothes, no matter how tightly they fit, there is always interposed a layer of air which is warmed by the heat of the body; it is thereby driven through the meshes of our under garments, the texture of which forms a set of capillary tubes through which air, aqueous vapour, and actual water (sweat) can pass more or less rapidly or evenly according to the thickness of the material and the closeness of weaving of the under-garment.

Conduction through the Material of the Clothes.—Some heat is undoubtedly lost this way, though probably quite a small amount compared with that lost through the air and sweat; it can best be appre-

ciated in daily life by the difference between getting into sheets and blankets, or between wearing a woollen shirt and a linen one next to the skin; we shall, however, discuss this matter more fully under the next heading (*vide* below, p. 105).

Through the Sweat.—There is not a square inch of the surface of the skin that has not a large number of sweat-glands opening upon it which are constantly at work pouring out their secretion on to the surface. It is true that the rate of this excretion or secretion varies very widely indeed (as may be easily appreciated by noticing the skin after a game of tennis on a hot day or after a cold drive in an open vehicle on a cold winter's day), but it is always going on and is always causing a loss of heat in two ways, (1) by evaporation, (2) by the fact that the sweat is warmed at the expense of the body.

(1) *Evaporated, or Insensible, Perspiration.*

When the flow of sweat is at a minimum the minute drops of warm sweat which reach the opening on the skin at once evaporate into aqueous vapour and do not become appreciated as a liquid on the skin, but the effect of this evaporation is to abstract a considerable quantity of heat from the body, or, to put matters in a rather different way, this evaporation is produced by the heat of the body, which heat is thereby lost to the body (*vide* p. 106). We must follow the aqueous vapour thus produced a little

further; it diffuses into the air next the skin and so through the layers of clothes which are nearest to the skin. As it gets through the clothes it gets cooled, because it is getting further away from the warm skin, and as the cooling goes on, or if the exterior air is saturated with moisture, our particular vapour is condensed in the form of water on some part of the clothing away from the skin. This seems a very elaborate explanation of a process which a nurse may perhaps hardly appreciate, but let her think of the clouds of steam which on a cold winter's day are to be seen at a few inches distant from a horse's skin after he has exerted himself pretty sharply; it is exactly similar to, and has exactly the same explanation as, the more copious clouds near his nostrils, but these have come from the lungs, not the skin. What is apparent enough here is merely an exaggerated stage of what is constantly going on from our own skins day and night—now more, now less rapidly, but always there, and is one half of the secret of a constant bodily temperature in health; in disease a copious perspiration is often seen with fever, but this need not be discussed here in elementary hygiene.

(2) *Warm Sensible Perspiration.*

With regard to the more obvious sweat, that which can be appreciated as a watery liquid; this is warm and has been warmed at the expense of the heat of the body, it trickles down the skin under the influence

of gravity or stays on the spot of exudation until it is touched by the clothes, and is then by capillary attraction absorbed by the clothes and permeates them, and it is important, from the point of view of clothing, cold feet, catching a chill, etc., to follow the fate of this actual moisture just as we followed the fate of the so-called insensible sweat.

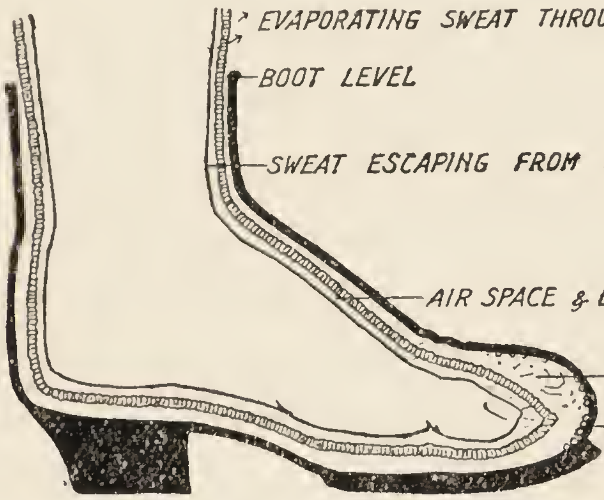
It soaks through the layers of warm clothing next the skin and reaches the exterior parts, which are certainly less warm, and so it has lost the heat which it had taken from the body (some may go back to the skin, *vide* p. 108) and forms a cold bath for the outer side of the clothing, and from that bath may be gradually evaporated into the atmosphere; it will be so if the atmosphere is dry and warm, but it will be the less evaporated the colder or the moister the atmosphere. This evaporation on the outside of the clothes cools them just as the evaporation on the surface of the skin cools it. All this is a detailed account of "letting our clothes dry on us," and inasmuch as this drying always absorbs or uses up heat, it explains how we may get a chill from this act of carelessness.

The above rather elaborate explanation of the action of the sweat can more easily be followed by noting the written points in the figure 13. The boot is clearly shown; the stocking is marked by small transverse lines; the aqueous vapour, both outside and inside the stocking, is well shown by the toes and the little drops of actual watery sweat recon-

densed on the boot. The whole thing is exactly as described on p. 67 in the natural history of water, and though the foot only is used as an illustration the same sketch holds true of all parts of the body, under and outer garments being substituted for stockings and boots.

Such is a fairly complete, and I hope not too

FIG. 13.



elaborate, explanation of the part the skin plays in keeping the heat of the body constant; we must now discuss how clothes help (or hinder) the matter.

CLOTHING IN HYGIENE.

Common experience undoubtedly proves that in hotter climates clothing is unnecessary for natives, but it is equally certain that it is more or less necessary in England, though, except for decency's sake, it may be less necessary and of less consequence than is usually assumed to be the case, for we must not forget the old tale of the North-American Indian,

who on being found nearly naked in mid-winter and being asked why he did not clothe himself more appropriately for the weather, asked in turn why his interrogator did not cover his face, and on receiving the reply, "Oh! my face does not require it," blandly again replied, "Me all face." It is this tale, founded, as it may well be, on fact, that makes one doubt the absolute necessity of many articles of dress and the exact truth of elaborate rules of dress.

It cannot be too frequently nor too strongly insisted upon that the body *must* lose heat through the skin, and consequently, when a nurse tells me that we wear bad conductors next our skin to *prevent* heat escaping from the body, it shows that she has not exactly understood the position (or does not understand the meaning of the word prevent).

Now, as a matter of fact, the clothes we wear serve some two or three purposes of more or less importance according to circumstances.

(1) They protect the body mechanically against minor degrees of physical violence; compare a naked individual with one who is clothed, trying to struggle through a blackberry bush; of this obvious purpose I shall make no further mention.

(2) They help to regulate (not "they prevent") to some extent the loss of heat from the skin.

(3) They give us pleasurable feelings of warmth and comfort, the absence of which, or the opposite of which, constitute feelings of cold or chilliness or actual shivering, which may or may not be dangerous.

(4) External clothing keeps off rain and serves other purposes.

The last three points we will now proceed to discuss.

CLOTHING AS DIRECT REGULATORS OF HEAT-LOSS.

The clothes can help or hinder heat-loss by three of their qualities, viz.: (*a*) Thinness or thickness; (*b*) looseness or closeness of texture (weaving); (*c*) material, good or bad conductor of heat.

(*a*) Thickness: This is a fairly obvious point, for it stands to reason that the thicker the garment the longer will it take air and aqueous vapour to pass through it, and the greater will be the difficulty in the way of external air penetrating to the body.

(*b*) Closeness of texture is a somewhat similar point, for the closer the texture the smaller the spaces through which air has to pass, and the smaller these spaces the more the difficulty of passage.

This statement must be accepted by nurses on faith, as to explain it scientifically would involve the introduction of friction in fine tubes and capillary attraction, both too technical for introduction here.

(*c*) Material: This is very largely, for under-garments, at any rate (leather overcoats and waist-coats are a different matter), a question of conduction of heat. None of the ordinary materials for under-garments, linen, cotton, silk, and wool are really good

conductors of heat, in comparison with metals, for instance; they will conduct it, however, with moderate freedom, linen and cotton very much more freely than wool, and silk also more freely though not so much more as the other two.

All the three qualities have this common scientific basis, that between the individual fibres of all materials, however thick and however woven, lies air; now air in motion or freely movable is a good convector or carrier of heat, but air in a confined space, as it exists between the fibres, unable to move, or only slowly, is a bad conductor of heat. Consequently, it is quite possible to have a loosely woven, rough, thick, linen or cotton garment which shall preserve the body heat, and feel as warm as a thin, tightly woven, smooth, silk or woollen one, but there are obvious practical disadvantages in laundry and cleansing processes, in making clothes which go next the skin of anything but silk or wool, or material containing a large proportion of these substances.

CLOTHING AS A SOURCE OF PLEASURE OR DISCOMFORT OR EVEN DANGER.

Under this heading we have to deal more with sensory impressions than with actual physical heat problems; though, no doubt, the former depend to a large extent upon the latter there are still many little problems of daily life which depend upon physiology even more than on physics.

Pleasurable Feelings of Warmth.

To promote these, the following simple rules are conducive and quite sufficient.

(1) The materials from which our under-garments are made should be bad conductors of heat and good absorbers of moisture.

(2) The manner and methods in which these materials are converted into garments should not be such as to unnecessarily interfere with whatever qualities in these directions the original materials possessed.

(3) The under-clothing from the stockings upwards should be in actual physical continuity.

For healthy adults this "bad conductor next the skin" is a matter of comfort and pleasure; for babies it is more important, because for their weight they have a relatively much larger skin surface (for losing heat) than adults; for invalids and convalescents it is also more important, for they may require to preserve their heat more closely than those in perfect health. During sleep both in health and convalescence the matter is also of importance, for during sleep the actual production of heat in the body is reduced to a minimum, and it may be all required; and not only so, but a feeling or sensation of cold may prevent sleep or wake a sleeper. Sleeping between blankets is indicated to promote this feeling of warmth, or long flannel nightgowns and bed-socks reaching to

the knees for those to whom the roughness of blankets is uncomfortable.

N.B.—A garment not only feels warmer but is actually warmer to wear in proportion as it retards heat-loss.

As regards the absorption of sweat, the garment next the skin should be capable of rapidly absorbing any sensible sweat that appears; it is distinctly uncomfortable, to say the least of it, to feel this fluid trickling over the skin; but when it comes to asking how this absorption can best be promoted, there seems no doubt that cotton and linen, considered merely as material, are able to absorb moisture more rapidly than silk or wool, for the latter at any rate is distinctly greasy and so hinders capillary attraction (*vide* p. 162), and but rarely has its grease so completely removed as to permit this force to act as quickly as do the other materials (a statement to the contrary appears in 'Parkes's Hygiene,' but I cannot help but feel that it is contrary to common experience). However, leaving rapidity of absorption out of the question and considering the garment as a whole, there can be no doubt that for going next to the skin, wool (or mixtures containing it) is the better material for these garments owing to two factors: (1) Woolly mixtures are thicker and therefore can actually hold more moisture without feeling actually wet; and (2) the old question of conduction of heat; they feel warmer,*

* There is a rather deep scientific reason for this in that, as the vapour of the sweat recondenses in the clothes, it again yields

even when wet, than do cotton and linen, and therefore more comfortable and even safer for health, supposing a chill dangerous.

The continuity of under-clothing from the stockings upwards is an obvious point in preventing draughts from reaching the abdomen and pelvic regions. Happily for women, saner methods of under-clothing seem to be coming into fashion, and it is now quite possible for a woman to dress so that the legs and abdomen are as warmly clad as is the case with the male sex, and certainly this method should be adopted so far as the garments actually in contact with the skin are concerned. Under-vests and drawers, with, at the least, a large proportion of woollen or silk material, or knickerbockers in actual continuity, as in the shape of so-called combinations, or in virtual continuity by the drawers being fixed above the lower limit of the vest, are essential, and should be insisted upon by those who are responsible for the clothing of young girls, so that habits may be formed that will last when the time of adult life and independence arrives.

Feelings of Chilliness.

We have considered somewhat fully the preservation of body heat and feelings of warmth. A few paragraphs on the converse feelings of coolness may now be given.

up some of the heat used in vapourising the water, and this reaches the skin more easily than it is carried through the garment.

It is very probable that as regards a draught, *i.e.* cold air impinging on a local area of skin and cooling it and thereby causing a sensation of "cold" by evaporation of sweat, a great deal of irresponsible nonsense has been talked and written, but none the less it is equally probable that, for invalids and sick people, there may be an element or basis of truth in the view that such a local cooling has its dangers, and certainly it has its discomforts if nothing else, and is best avoided, at any rate as regards those parts of the skin which are not habitually uncovered and so exposed to the ordinary temperature of the air. It is difficult to explain or even to understand any difference between such local cooling and the general cooling of the body when we are more or less naked in a cool atmosphere, and difficult to see why one condition should seem to lead rather often to serious illness and the other not to do so. But there is this to be said, that there is generally a subjective feeling of real discomfort in the one case and often only a pleasurable feeling of coolness in the other; not that this can be taken as a very reliable guide either, for it would seem—possibly though things are not always or, indeed, generally what they seem—that equal trouble may arise when the sensation of coolness is entirely pleasurable, when, for instance, after exercise (tennis, dancing, etc.) one sits in a "cool breeze," finding it extremely pleasant, but the consequences are sometimes the reverse of pleasant. Anyhow, so far as a nurse's own health is concerned,

and so far as she can advise and assist her patient, she is acting more wisely if she takes up this position. "It is unwise to allow a local sensation of actual cold to continue, and especially so if such sensation is unpleasant, and particularly should she not allow in her own person or in that of her patient a sensation of shivering to continue, though probably if mischief is done at any time it is already done when the shiver occurs."

Now, whatever may be the case of danger or safety with regard to a draught of air, there can be no doubt at all but that a *local* sensation of cold on the skin from water has under ordinary circumstances very commonly a baneful effect—I am not here, of course, talking of a genuine cold bath with the clothes off, but of sitting in admittedly wet clothing after tumbling in the water, sitting with wet feet, and even sitting still after violent exercise, for these are the sort of circumstances under which such sensations arise. The "why" of these ill effects can vaguely be perceived in a general sense, though to give more precise reasons for them in any given individual case is much more difficult. The "how" to avoid the sensations is easy and straightforward, viz. to change damp under-clothing at the earliest possible moment for dry garments, especially damp socks or stockings, and secondly, to keep the feet off the floor by foot-stools, and thirdly, to make a habit of wearing under-clothing that is a bad conductor of heat (*vide* p. 106).

Cold Feet and Hands.

What is the explanation of cold feet and hands? How can they be avoided?

There are two or three reasons for cold feet and hands. *A, the distribution of blood to them.* The feet and hands are farther away from the heart than any other part of the body, hence the blood which reaches them from the heart is probably a trifle cooler than that which reaches the brain or stomach; secondly, in the case of the feet, at any rate, the actual number and size of arteries supplying them with blood, and the freedom with which these arteries unite with one another so as to allow a free circulation of hot blood, is comparatively less than the similar arterial distribution of other organs; and thirdly, there is, again more particularly in the case of the feet, a somewhat increased difficulty in returning the venous blood back to the body to be warmed up again and purified, a difficulty much accentuated by ill-fitting boots and by tight garters or bands round the legs. *B*, There is the question of the *actual temperature to which the extremities are exposed;* this is, of course, quite simple, and is the same for all other parts of the body, and is dealt with by clothing being judicious and appropriate (*vide* p. 103). *C*, There is *the question of the perspiration*, which it seems very difficult for a nurse to appreciate in the case of hands and feet, but it cannot be too much insisted upon that the hands and feet are very richly supplied with sweat-

glands, which are always in action, either vigorously or less energetically, but never ceasing. The heat is used up in evaporating this sweat to a state of vapour, the vapour comes in contact with the cold boot, and unless there are good, thick, warm stockings the feet soon get into a cold bath, and the sooner the less pervious to vapour are the boots. Precisely the same may happen to the hands if kid or leather gloves are used in cold weather. When india-rubber goloshes or patent leather boots or shoes are worn, these prevent the escape of any aqueous vapour through the boot and so compel it to stop inside, probably not as vapour but as actual moisture, thus giving the foot a cold bath.

What is the remedy for cold feet? To counteract the difficulties of the circulation there is obviously nothing to be done but to take exercise and so promote the rapidity of the access of warm blood and the removal of the cooler venous blood. This will also, it is true, increase the excretion of sweat, but will provide the extra heat (and perhaps a bit to spare) required to evaporate it, and not only so, but to warm the stocking and the inner surface of the boot and keep it as vapour, and what is then required is that the aqueous vapour shall easily penetrate the stocking, and that when it has reached the outside of the stocking, *i.e.*, the inside of the boot and further outwards, and has been again by cold reduced to a state of actual water, there shall be a material which will absorb this moisture and as far as possible prevent it touching the foot.

Avoidance of garters and bands, and of ill-fit, etc., of boots are obvious remedies. For invalids and others unable to take exercise, hot-water bottles and bed-socks are equally obvious.

EXTERNAL GARMENTS.

It is, of course, in these outer articles of dress that cut, fashion, shape, and ornament are perhaps the main considerations of the feminine population, and with these the hygienist and sanitarian has little or no concern. The material and length are, however, of some importance from his point of view, so far at least as nurses are concerned.

(1) For outdoor wear, woven wool (*i. e.* cloth dresses) with a fair quantity of its natural grease left in is undoubtedly the best, inasmuch as it fulfils the following conditions :

(*a*) It allows reasonable ventilation of air, so that perspiration can escape with sufficient readiness.

(*b*) It allows of a moderately free passage of heat from the body and conversely a medium feeling of coolness from the atmosphere.

(*c*) Small quantities (slight showers of rain) of water will more or less stop on the outside of a skirt and can be shaken off.

(*d*) Larger quantities can actually be held by it, owing to its thickness, without allowing water to soak through to the under-garments and make them wet.

(*e*) Within fairly wide limits, such incidents as rain and wind do not actually spoil the garment. A

good shake, drying, and a brush, will restore it to a good condition.

The objection that it has a rough surface and so is likely to catch and hold germs and other noxious substances is really of not much weight, so long as a little care is taken in choosing the place where the brushing process shall go on.

A more serious objection, perhaps, is the difficulty of thorough cleaning, or of washing, such material.

(2) For indoor wear, and especially for nurses' uniforms, it is practically essential that some form of cotton or linen material must be used, on the following grounds:

(*a*) A nurse's uniform must, from the nature of her work, be particularly exposed to soiling by very objectionable material (blood, pus, excretions, etc.), and therefore it is absolutely necessary that its material should be capable of being cleaned and washed in a most thorough manner (boiling, disinfectants, etc.) without being spoiled; cotton and linen are almost the only materials at reasonable cost that will permit of such treatment.

(*b*) The smoother surface or gloss which can be put on such material certainly offers less foothold for germs and dust.

(*c*) A nurse should always look neat, tidy, and clean, and to do this it is really necessary that she should have a frequent change of dress, and this entails a serious cost unless the material is reasonably cheap.

The only objection to such external material is that it affords in winter but poor protection against cold when walking. This has, however, its weight removed by the fact that it is easily remedied by a cloak of woven woolly material, and in summer for mere garden use the material has no such objection.

Of furs, it is only necessary to say that they are very nice looking and distinctly warm, not only from the entanglement of air between the hairs but because of the layer of leather which the prepared skin of the animal makes on the inside of the fur, both facts serving to check the escape of heat from the body. They are thus very pleasant companions when riding or motoring, or sitting in a cold atmosphere, and in some countries in winter are really indispensable, perhaps even in England, too, for some, such as chauffeurs, coachmen, etc., whose occupation is very exposed, but hardly enter more seriously into nurses' hygiene. With the hair turned inside they are warmer but don't look so nice.

As for flounces, frills, and petticoats for fashion and appearance but little need be said: their wear, shape, material, and colour are governed by laws far outside the scope of the hygienist, and have really but little essential interest for him except in one comparatively minor point, viz. that when long and voluminous they form dust traps, and so in shaking and brushing possibly bring deleterious microbic inhabitants within reach of the respiratory inlets. The length of a plain dress should be moderate; for the

same reason long skirts are a hygienic abomination.

Mackintoshes and Goloshes, etc.

Let us now take the history of what happens when these are worn: The sweat, sensible and insensible, reaches through the clothing into the inner surface of the rubber, either as aqueous vapour or as moisture, actual liquid; it is now incapable of getting through or soaking into the rubber, and consequently can only collect on this inner surface and render it damp. Now, the rubber worn as a protection is always thin, and therefore the inner surface is practically at the temperature of the air, usually a good deal colder than the temperature of the body; hence it does not take very long before we arrive at the position that the body is surrounded by a cold bath—a thin layer of cold water. It is true that evaporation and the loss of heat thereby entailed is prevented, but this cold water can, and does, absorb a lot of heat without getting warm: and hence we can see that—worn in summer, india-rubber is very hot, but if we then sit in a cold place we can, even on a hot summer's day, rapidly cool the skin too freely; worn in winter it is very cold and chilly and even dangerous when worn for any length of time, and, as a matter of fact, india-rubber goods of any sort should never be worn for anything more than a quite temporary purpose.

The Colour of Clothes.

It is only in external garments that colour *per se* can be of importance, and certainly on a hot day, or in the tropics, the colour of these should approximate to white, owing to the fact that white reflects a great deal of the radiant heat of the sun. In winter and on sunless days, dark or black outer garments should be worn because they absorb a large proportion of the same radiant heat.

There is a very important point in the colouring of all under-clothes, viz. to see that it is a "fast" colour, *i. e.* that the colouring material or dye will not dissolve in the warm moisture of perspiration or in rain and so get on to the skin; it is not only unpleasant to have one's skin thus discoloured, but many serious cases of poisoning have thus arisen from the use of aniline dyes (probably improperly mordanted, or fixed in the fabric), the dye being absorbed through the skin.

How Clothes should be fixed on the Body.

The means by which clothes are held upon the body is of some little importance, inasmuch as tight bands are distinctly inadvisable round the legs. Probably in the present state of civilisation stays are, when well fitting, about the best means of support to a woman's body, and afford more or less convenient points of attachment for other garments; certainly

garters should not be worn so tightly as to offer any sort of impediment to the return of blood from the foot and lower leg, which are quite sufficiently ill-placed for this purpose without any additional difficulties.

It is a mistake, however, to imagine that even moderately tight garters affect the *muscles*; it is the circulation in the *veins* beneath the skin that is impeded by pressure on their soft walls, and it is this pressure that should be avoided.

In thus damning stays with faint praise, one must not be taken to be admitting that the modern corset, as judged by the pictures in advertisements, is an unalloyed blessing. Certainly some such figures as are thus portrayed cannot be regarded as anything but badly deformed monstrosities, and a nurse should certainly be warned against trying to get her waist down to eighteen inches.

Weight of Clothes.

It is certainly advisable that clothes should not be heavier than necessary, and that the weight should be as evenly distributed as possible. The reasons are not far to seek, but it is just as well to make them quite clear.

Carrying a weight, no matter how distributed, whether in the boots or on the body, involves the output of force or muscular energy, and this in turn (*vide* pp. 10 and 98) involves the production of a consider-

able amount of heat in the body, which heat has to be got rid of (at least the surplus has to be dissipated), and we have already shown (p. 96) that the skin is the great organ used for getting rid of heat, and the sweat the chief means used by the skin for this purpose, hence it follows that the more weight is carried the more sweat is likely to be produced, and the more sweat there may be the greater the difficulty of arranging for its disposal without doing harm to the body. This, in health, may not be a matter of much difficulty, but for invalids and convalescents is not only difficult but may involve the dangers of too rapid cooling or too great heating of the body, not to mention the possible exhaustion produced by putting forth so much energy. The moral of all this is—when necessity compels exercise in bad or even cold weather wear warm under-clothing and *do not* wear a heavy overcoat.

Obviously the above remarks refer only to states of active movement on the part of the wearer. When he or she is seated in an open motor-car on a cold day it is almost impossible to have the clothing for all parts of the body too thick, and weight within reasonable limits may be quite neglected. In other words, clothing should be adapted to occupation, both indoors and out-of-doors.

Inflammability of Clothing.

It is from the very numerous accidents that occur that this point derives its importance; every year

some dozens, perhaps hundreds of people, are severely, even fatally, burnt, owing to the ready inflammability of their clothes; children dressed in flannelette (really cotton) are the commonest victims, but adults with cotton and linen garments also suffer at times. An incident of the war, of which I have intimate personal knowledge, has led to an order that nurses on active service, at any rate, shall not wear celluloid cuffs or collars. Celluloid is very inflammable material, almost, one might say, explosively so; at any rate, it can burn in an atmosphere devoid of oxygen, which ordinary cotton and linen cannot do or with the greatest difficulty. The incident is worth recording in detail, as it has points in it worth noting other than the celluloid cuffs and collars.

Some nurses in a railway carriage at the rear of the army tried to make tea; for the purpose they had a spirit lamp and kettle. From some reason or other the lamp went out. Thinking it required more spirit, one nurse held it while a second one poured more spirit *into a hot lamp* or on a wick with a spark still alive in it; the immediate consequence was that the loose spirit blazed up and set fire at once to the celluloid cuffs and collar. Nothing but the presence of mind of a third nurse prevented a fatal catastrophe; she promptly enveloped the blaze in some woollen garment and literally crushed it out.

It forms an excellent illustration of the dangers mentioned on p. 38.

Cotton and linen are easily burnt, silk less so, and wool least easily of any.

I purposely omit from this edition the table of advantages and disadvantages of various clothing

material, first, because a nurse ought to draw one up for herself if she wants one, and secondly, because advantages and disadvantages are relative terms not infrequently changing one into the other according to circumstances of occupation.

Boots and Shoes.

Considering the many millions of people who from the cradle to the grave never think of wearing boots, shoes or sandals, or any form of covering for the feet, it is quite obvious that these are pure luxuries and products of artificial modes of life, but as we live under such conditions, the only conclusion that can be drawn from the above is very simple, but at the same time of very great importance, viz. *that the covering should be made to fit the foot, and not the foot to fit the covering.* Corns, bunions, and deformities of all sorts are the inevitable results of the latter practice, which unfortunately fashion and the inexplicable vagaries of so-called civilisation have fixed upon unfortunate youths and maidens.

It cannot be too strongly insisted upon that the foot is as much an organ of the body as is the heart, or the lungs, or the hands, and as such has to grow, and grow it will. If a person has large hands no one dreams of cramping them in very thick and hard leather gloves all day to make them smaller, or distort them into some fancy shape: a merciful Providence has ordained that they shall be too useful to

be thus ill-treated and damaged, though many a person, especially if a girl, will try to wear No. 5 gloves when 6 or 6½ would be more appropriate, but this is of comparatively little harm, inasmuch as they are worn only for short periods intermittently.

Now think of the foot. Its main function, I admit, with us, at any rate, is a means of support; that it can be used almost as a hand is proved by many instances of persons who have lost a hand, but even with us a healthy foot is by no means a mere *passive* basis of support. It has many separate joints in it and a wonderfully complex system of muscles, ligaments and arches, all of which come, or should come, very actively into use in movements of the body in the upright position; each individual toe does his own little bit of work in preserving a natural ease and smoothness of balance in standing, walking, etc., and every bone, ligament, joint and muscle is worthy of attention. The more the foot, or any part thereof, is pinched up or distorted, or even held in a fixed position for all movements, the more does it as a whole lose all the small finer adaptations and movements in its separate parts, and the more does it become a simple passive support, very ill-adapted to finer adjustments. Not only so, but each joint, muscle, and ligament resents the treatment to which it is subjected, and becomes either idle or functionless, or more actively retaliates on its tormentor and becomes the seat of a painful affection (corns, tumours, sore places, etc.), the pain and the ultimate results of

which extend far beyond the foot, making ankles, legs, knees, thighs, and even the whole body ache badly.

These considerations, then, lead us at once and directly straight to the second important principle—*that the size of the boot or shoe should be the easy size of the foot when standing, i.e.* when the weight of the body is stretching the arches of the foot in length and in breadth to an ordinary average extent; this is the real essential principle of foot-gear manufactory. No foot is naturally of a pointed shape, and if pointed or curled or dragon-headed shoes are in the fashion, let the point, curl, or dragon, be added on at that portion of the shoe into which the toes do not reach; it can then do no harm to the foot at any rate, and may please the individual or collective fancy of wearers of such gear, but do let the toes have free and fair play in their own shape.

So much for the size of the sole, which is most important. As for its thickness, that is a question, on the one hand, of not having them too thick, lest the weight prove too tiring and clumsy, on the other, of not having them too thin, lest stones and other inequalities of the ground—pins, needles, and thorns, etc.—be felt through the too thin covering.

The heels should certainly be built on the average thickness of a man's boot; high heels are one of fashion's decrees that must certainly tend to throw all the weight of the foot forward on to the toes; the foot must tend to slide down the hill produced by

the heel and the toe and so jam the toes against the end of the boot, and it is easy to see that the steeper this hill, *i.e.* the higher the heel, the greater this tendency and the worse for the toes. It is true that the lacing-up in front may check this to some extent, but there is no sensible reason on earth why a woman should always be walking, so to speak, down hill, and make herself in the likeness of a hare, whose hind-legs are much longer than the fore-limbs; it is all very well for the hare, whom Nature has built in that way, or perhaps more truly has adapted to her habitat, but it is not good for women to try to arrive at artificial adaptation to levels which Nature has no inclination to force her on to. That low heels produce flat-foot is a fallacy, they do nothing of the sort.

So much for the foundation of the boot. As for the uppers, it is obvious that the softer they are and the more pliable the more they will adapt themselves to the natural contour of the foot in its various attitudes and shapes, and the more elastic (*vide* defn.) they are the neater will they look, and the more general comfort they will give to the foot or ankle by a sense of comfortable support.

Laces v. *buttons.*—Undoubtedly laces are rather better than buttons because they afford a better adaptation of the upper to the shape of the foot; they can be loosened or tightened at will, whereas buttons are at a fixed distance which is practically invariable; on the whole, too, they are less trouble and take less time to fasten.

The question of boots *v.* shoes is largely a matter of habit and custom; undoubtedly, on the one hand, boots offer better protection to the ankles and the legs as high as they reach, and certainly in mountain climbing and rough walking they prevent many a sprained ankle; on the other hand, they are heavier than shoes and hotter round the ankle for indoor wear, but, as a matter of theoretical hygiene, there is little else to be said about them.

For a few further remarks *vide* under "Cold Feet," and also pp. 65 and 112.

VENTILATION.

The Constitution of the Atmosphere.

The air of our atmosphere consists of about 20 per cent. oxygen and 79 per cent. nitrogen ; the balance of approximately 1 per cent. consists of a variety of other gases, *vide* below. The oxygen is the necessary part ; the nitrogen is to dilute the oxygen. Pure oxygen is not a good thing for us to breathe constantly and habitually, though often thought to be of use in the sick-room.

The 1 per cent. of things other than O and N is worth a little consideration both in its nature and origin.

Nature of the 1 *per cent.*—CO_2, or carbonic acid, amounts to about ·04 ; it is usually said to be deleterious in action when it reaches much above ·4. Modern physiologists are now in some doubt as to the actual harm of the CO_2 itself, but as it is always (in dwelling-rooms at any rate) found with other deleterious matters it certainly serves as some sort of measure of these, and the object of ventilation is to keep it and its associates as low as possible—some-

where between the expected ·04 and the 4 per cent. which is present in the air as it leaves the mouth or nose, and the nearer the lower limit the better.

Aqueous vapour.—This is a constant constituent (in traces or more) of all air, and modern physiology is inclined to blame an excess of it for most of the troubles of "stuffiness." Common observation teaches one that we feel happier in a dry than in a damp atmosphere, and no doubt the explanation lies in the help and hindrance to sweat evaporation (*vide* p. 100).

Dr. Leonard Hill is of opinion that it is the stagnation of moist air that is really deleterious, and he has proved that the mere stirring up of such air by fans (artificially moved) is sufficient to give great relief.

Ozone is a curious form of oxygen with an unpleasant smell, but with excellent qualities for breathing; it is found chiefly by the sea and around mountain tops, but it is in very minute traces anywhere.

Anything else than the above three must certainly be looked upon as an undesirable impurity. For the effect of rain on the air, *vide* p. 67.

Sources of the 1 *per cent.*—The CO_2 is practically all derived from living things, animal or vegetable, and from fires of all sorts.

The H_2O vapour gets into the air from everywhere where water exists; it is practically ubiquitous. So far as living-rooms are concerned it must be

admitted that its most important (perhaps not its greatest) source is expired air. Ozone is formed by the action of electricity upon oxygen; perhaps also by the action of sea-water or rather of the violence of the waves upon the oxygen. The other impurities, of which we may enumerate coal-gas, manufactory fumes, sewer gases, volatile acids, and ammonia, are the products of man's activities in producing the various substances used in trade, etc.

These, however, in their deleterious qualities sink into absolute insignificance compared with the suspended matter with its millions of microbes.

Amount of Air required for Man.

It is commonly assumed that a person in health requires 3000 cubic feet of fresh air per hour, and that a sick person is better with half as much again, or 4500 cubic feet. This is worked out on the basis of diluting the 4 per cent. of CO_2 found in the expired air down to something less than 1 per cent., assuming each breath to amount to some 22 cubic inches. The sick man wants more because, especially if he has pyrexia, he is using up his available supply of oxygen in his blood and tissues more quickly than in health, and if he be not pyrexial it is still advisable that he should have plenty of fresh air.

How is this Amount to be obtained?

There are two broad systems of ventilation, known respectively as artificial and natural.

Artificial systems.—These are constructed on two principles—one known as the extraction method, the other as the propulsion method. They are far too complicated in their details to be described in an elementary work; suffice it to say that in the first, or extraction system, the used-up air in a building is sucked out at or near the top through a suitably situated and constructed pipe by means of an air pump, fresh air properly warmed, purified, and broken up in its momentum (*vide* p. 60) being ad-

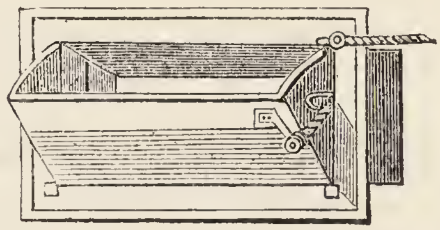


FIG. 14.—Sheringham valve.

mitted towards the lower part of the building. In the second, or propulsion method, fresh air properly warmed, purified, and broken up in its momentum is forced in at the bottom and allowed to escape at the top by pipes or exits situated conveniently.

Natural systems.—All these depend for their working on (*a*) the currents of air produced in a room by differences of temperature at various levels in it, these temperatures being produced in turn by the ordinary means of gas, lamps, a fire, hot-water pipes, etc.; (*b*) currents of air outside a room being allowed to enter by windows and other simple contrivances such as Sheringham's valve or Tobin's tube (*vide* Figs. 14 and 15, which, with the arrows showing the

direction of air-currents explain themselves), all dependent on the winds of heaven and their strength and direction; (c) the natural diffusion of gases (*vide* p. 66), which should be always assisted by some contrivance (*vide* Figs. 14 and 15).

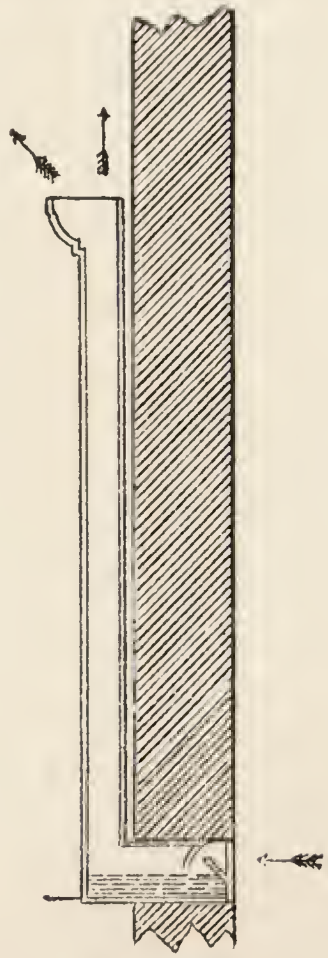


FIG. 15.—Tobin's tube.

With the exception of being able to close or open a ventilator and of being able to open or close a window a nurse is equally powerless with these natural systems as she is with the artificial ones, for she cannot order them to be put in the walls, and we do no more than insert the figures of these contrivances. Hinckes-Bird's plan of opening a window at the bottom, fixing a bit of board in the opening so pro-

duced, closing the sash down on to the board and so leaving a space between the two sashes of the window, is, however, worth showing in two positions, as it demands the ordinary two-sash window and a piece of board about four inches deep and as long as the

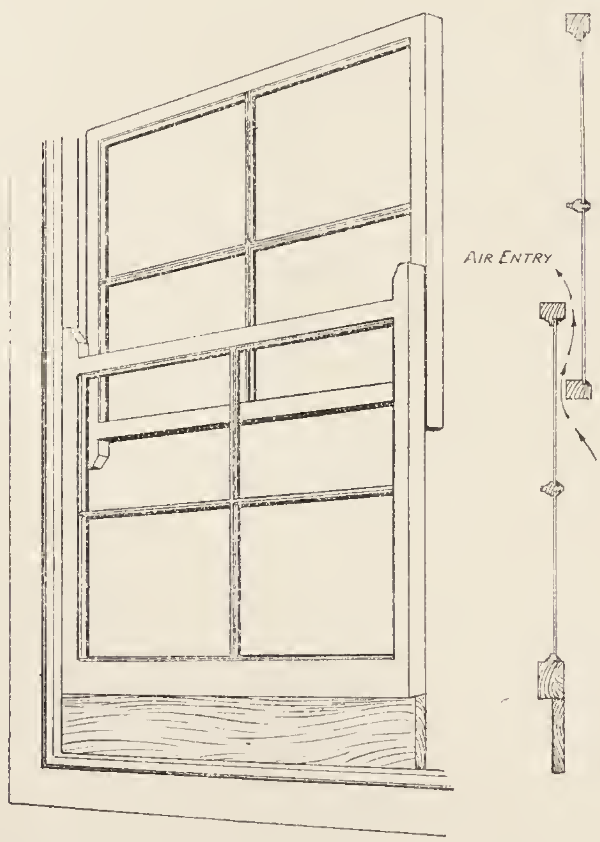


FIG. 16. FIG. 17.—Side view of Fig. 16.

window frame is, so that it may fit the opening of the bottom sash (*vide* Figs. 16 and 17).

Now let us see how the matter works out in practical nursing:

What may be taken as an average sized bedroom? Making a rough estimate in cottages, it is, perhaps, 12 ft. long by 10 ft. broad by, say, 8 ft. high, or 960 cubic feet of space. Take, then, rather better-class

houses: here perhaps 15 ft. long by 13 ft. broad by 9 ft. high, or 1755 cubic feet, and in really good houses perhaps 20 ft. by 16 ft. by 10 ft. may not be an out-of-the-way estimate, or 3200 cubic feet.

We have, then, three sizes of room—960, 1755, 3200 cubic feet capacity. Now, obviously, if a patient and one nurse, that is, two people, are to inhabit one of these rooms day and right, into the sick room there will have to be introduced 3000 for nurse, 4500 for patient, cubic feet of air per hour. Now, dividing 7500 by 960, 1755, 3200 respectively, we get, very roughly, the numbers 8, 5, 3 as the number of times that the air must be renewed in the room every hour in order to keep it quite fresh for the inhabitants. We have the door or doors and the window or windows to do it with. If there be a fireplace this won't count, remember, because that is, or should be, always an outlet.

The nurse can, if she be clever enough, measure these inlets and work out the problem of velocities of the air, but at the end of her sum she won't be much wiser, but for those of them who are mathematically inclined we might insert an answer thus: Suppose the door to be 7 ft. high and open 3 ft. (from edge of door to jamb when shut), and suppose there to be two windows, each, say, 3 ft. wide and open 1 ft. up, and imagine air entering freely through these holes and passing more or less round the room and going up the chimney, our equation runs thus: we have $7 \times 3 = 21$ square feet, and two spaces 3 ft. by 1 ft., or 6 square feet, a total space of 27 square feet. Then at 1 ft. per second or 60 ft. per minute we get 1420 cubic feet of air into a room every minute, or in an hour 85,200, which seems ample, but it must be remembered that this has to be done without producing a draught.

These figures, though correct and useful as far as they go for an examination, are not after all very helpful in actual nursing. So let us see what can be said that is useful.

Taking the cottage bedroom first, it is no good pretending that anything ideal can be done; the only practical plan is to get the patient to pop his head under the clothes, or at least to cover his body well up all except the face some two or three times a day, and then to open every window and door as far as they will go, and even use the door as a fan for some ten minutes or so, and let the wind have free play all over the room. This does give a thorough change to the air, and in the intervals the nurse must do the best she can by means of any little contrivance that is possible such as opening a window, etc.

In the better bedrooms it is generally possible to make some arrangement of the position of the bed with regard to the window, door, and fire-place so that the patient shall not constantly be in the direct line of the entering or departing current of air. If owing to the shape of the room or other circumstance, such an arrangement be not possible, the nurse must do the best she can with mechanical contrivances on p. 132, and adopt at intervals the cottage-bedroom plan of flooding the place with air. A change of room for an hour or two is sometimes possible.

Effects of Insufficient Ventilation.

When these are studied in the mass there can be no doubt about the evil effects on the general health-, sickness- and death-rate of a population; but when we come to consider them from the point of view of an individual patient ill from some given disease the matter is much less clear. We must, however, give a few brief statements on the subject, for it is really an important one even from a nurse's point of view.

We must start with an experience which is very common and therefore easily appreciated; a person, let us say, leaves home and goes to a meeting of some sort in schoolroom or private house, etc. On entering the room he says, "Oh! how stuffy," but in a few—seconds—almost, his nose becomes used to the atmosphere, and he no longer perceives it. After, say, half an hour or so he may (some are more easily affected than others) feel himself getting a little headachy, stuffy, perhaps a little faint or sleepy; or, on the other hand, he may feel nothing till he leaves the meeting and gets home again, when he very possibly finds himself with a headache and no appetite for his next meal; evidently the breathing the stuffy atmosphere of the room has done him harm. He is probably all right next morning and resolves never to attend another meeting in that room. But now suppose this meeting place is his own sitting- or bed-room, and instead of a special meeting it is his daily existence, it is quite obvious

that his health must suffer, and such, as a matter of fact, is the existence of thousands to whom fresh air indoors and especially in the bedroom is an unknown luxury, and their health does suffer accordingly; this is the wide general aspect of this question.

It is probable, however, that this aspect sinks into insignificance in comparison with other special aspects that may be mentioned, viz. the presence in the air of an ill-ventilated room of germs or microbes of disease quite unsuspected. It is the unsuspected that is the important point here. In a case of illness the germs are known to be there, and precautions taken accordingly; these unsuspected ones are given off in the breath or from the body or clothes of someone in the room not known to be ill, or to have the germs on his clothes, or stirred up off the floor and walls by the movements of the people in the room and by the opening and shutting of the door, and by draughts from cracks and crannies in the floor, and inhaled by the individuals whose power of resisting them is diminished by the ill-health we have mentioned, and so disease is spread and assumes evil proportions.

Bringing these two points to bear on a nurse in her work, it is very easy to see how harmful to her patient will be stuffiness of the room, how it may make his illness worse or retard his convalescence or cure, and again she may see the necessity of it from her own point of view. If the patient is ill from a disease known to be infectious, the details of her

personal action belong specifically to nursing details; here the subject is mentioned only in illustration of the need for ventilation.

Special Points about a Bedroom.

It is necessary to say a few words about the ventilation of a bedroom as opposed to an ordinary sitting-room, into and out of which people are continually passing. The conditions of the person in bed differ somewhat materially from those of one who moves about the room in which he happens to be. The facts about heat, etc., remain just what they are for a living-room, but we have to remember that for something like eight or nine hours the bedroom door remains closed, hence there is no big flush of air brought into the room by what is in effect a huge fan moving a big bulk of air. During these hours the individual also remains in one place, and it is only the trifling heat of the face, the current of expired air, and the natural diffusion of gases that can cause currents of air to play round the mouth—in other words, if fresh air is to reach the mouth it should be brought there by free ventilation, and the bedroom window should be wide open to allow air to enter freely. The matter of warming a bedroom cannot be passed over without a very strong word of warning against the extremely dangerous plan of bringing into it a portable stove of any sort (even a night-light or gas-jet is not good in an ill-ventilated bedroom); this

is lighted and no *direct* outlet from the room is provided for the products of combustion, which consequently diffuse themselves into the air the sleeper breathes: several deaths have thus taken place. Provided the sleeper is warmly covered up (*vide* "Clothing") there is no harm in a fairly strong current of even cold air playing on the face; remember the tale, "me all face."

Ventilation combined with Heating.

Now I will try to explain as simply as possible the differences between candles, gas, lamps, fires, and electricity, hot-water pipes, etc., for warming *and* ventilating a room. In the first four methods the actual source of the heat is the same, viz. the active oxidisation or burning of the fat, coal-gas, oils, or coal, and certainly these get their oxygen out of that which is in the room, and therefore it must be admitted that they do use up some of the oxygen which would otherwise be available for the persons in the room to breathe; but if this were all, there would be for equal amounts of heat no advantage one over the other, and in a well-ventilated room there would be oxygen enough for everything and everybody; but it is not all. We must go a step further and see what becomes of the products of combustion, CO, CO_2, water, and other undesirables; it is here that the principal hygienic (as opposed to matters of expense, convenience, etc.) difference comes in. The candles, lamps, and gas are unprovided with means

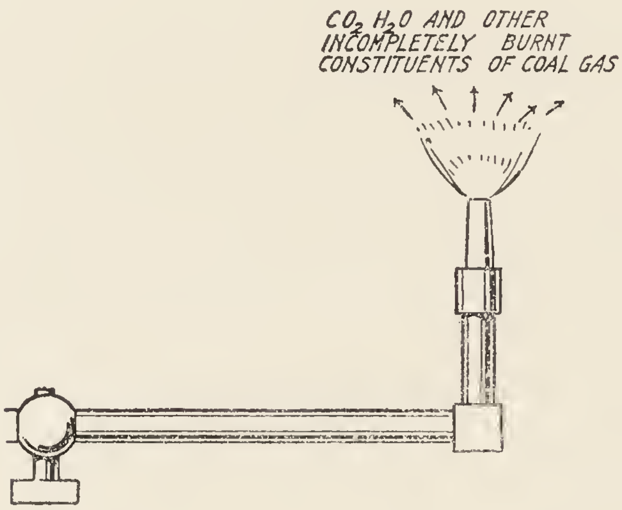
by which these *products can escape directly from the room* (lamps have chimneys, but these chimneys open into the room, not outside it); they must mix with the air in the room, and so lamps, candles, and gas not only use up oxygen, but also add their own waste products to the air which has to be used for breathing; this is a great point of distinction to be borne in mind. It must be remembered that even a small fire uses up many, many more times more oxygen than a large lamp or several candles or gas-jets, but, oxygen for oxygen, a lamp would warm a room more rapidly than an ordinary fire, because all the heat remains in the room while about four-fifths or more of the heat of a fire goes up the chimney. This is the meaning and explanation of the attempts made (in the nurse's sick room at the hospital, for instance) to utilise this heat of the chimney or flue by running it for some distance along the floor of the room so that the heat of this flue may act like a hot-air pipe.

In electrical warming, or warming by hot-water pipes, no oxygen is used up at all, and no waste pro-ucts are given off into the air of the room. (An electric light is a wire or thin bit of carbon heated to red heat in an atmosphere—note this peculiar use of the word—devoid of oxygen, or, indeed, any gas that can combine with the wire, so that it cannot burn—oxidise.)

Now, apart from the heat, how do these means compare for ventilation purposes? They one and

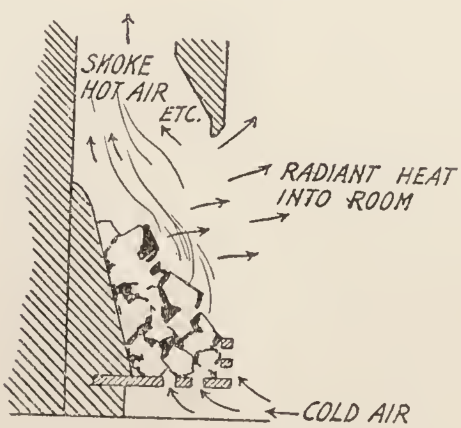
all act on precisely the same principle, viz. that when gases, in this case the O and N of the air of the room, are heated they expand or become lighter

FIG. 18.



and so rise to the top of the room, and colder air comes in below to take the place of the heated air which has risen. This must create currents of air,

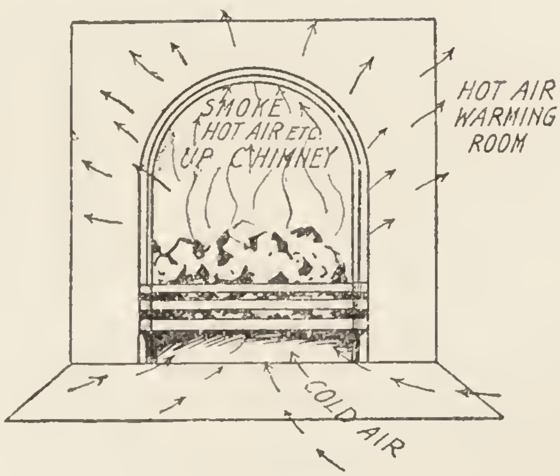
FIG. 19.



hot air passing away from the source of heat and cold air passing towards the source of heat; obviously, then, the more sources of heat we have the more currents of air there are and the more the air of the

room is stirred up, and if there are plenty of low inlets the better ventilated would be the room were it not for the consideration of the escape of the waste products above. Remember that ventilation may have two senses—one a mere stirring up or changing of air (*cf.* Dr. Hill, p. 128), the other a provision of good fresh air at a comfortable temperature—this is the more common meaning.

FIG. 20.



Figs. 18, 19, and 20, should be rather carefully studied in conjunction with Figs. 5, 6, 7, and 8 on p. 43, as they bring the eye into play as an additional aid to understanding the problems of ventilation and heating. The things represented in the figures must all be conceived of as being placed in a room. The room might have been drawn round each of them.

Fig. 18 represents an ordinary gas-jet without any *direct* and *immediate outlet from the room* for its products of combustion. Heat radiating from it as from the fire might have been depicted, but has been

omitted for simplicity. Figs. 19 and 20 show very well the important point of waste products (together, of course, with a lot of heat) escaping directly up a chimney out of the room, and so not contaminating the air of the room. Fig. 20 is a front view, and Fig. 19 a side view of a fire-place; note the cold draught towards the fire about on a level with the feet.

When asked about this subject, nurses always say a fire uses up oxygen, which is a disadvantage. Get rid of this notion. It uses oxygen, it is true, but not oxygen that is of use to the inhabitants of the room. The great disadvantages of a fire for heating and ventilating are: (1) the floor draughts it creates, and (2) so much of its heat is lost up the chimney, thus making it an extravagant method of heating; (3) the dirt and dust it makes; and its only real advantage over other methods is the—to English eyes, at all events—cheerful look of an open fire.

EXERCISE.

Re-creation.

In a nurse's life exercise is really a matter of little importance *in itself,* but the surrounding circumstances of the exercise are of the last degree of importance.

The first and last and only principles worth much in this direction are (1) the apparent paradox that the very best holiday is a change of occupation, and (2) that fresh air is a necessity of healthy life.

Let us deal with No. 2 first as the simpler of the two statements: it means this, that the atmosphere of a sick room is rarely as fresh and wholesome as it might be, and consequently, whatever time off duty a nurse gets, it should be spent, at any rate, a good proportion of it, in an atmosphere as fresh as possible, right out in the open, if weather and other circumstances at all permit.

(1) **Change of Occupation.**—If our paradox be analysed a little it will be found to be not quite so paradoxical as it seems at first sight, but it requires a little physiological explanation.

Let us first consider fatigue or tiredness: physio-

logists tell us that a muscle gets tired or fatigued when the waste products of its contractions are not sufficiently rapidly removed. Now the "sufficiency of rapidity" depends upon, first, the rapidity of the formation of these waste products, *i.e.* whether there is more or less of such products to be removed, and secondly, whether the circulation through the muscle is very free. This bit of scientific knowledge is all very true and well in its way, but we have to apply it to everyday experience, and then go a little further into the sequence of events.

Let a nurse pick up a small object of no particular weight, in her hand and carry this object up to her mouth 500 times; she will probably find by the time she has done so that the muscles of her arm ache or are tired; this tiredness probably corresponds to the fact that the muscles of her arm have got overful of waste products as the physiologists tell us. After a few minutes' rest she may be able to repeat the performance, but quite likely she will not, and she may say, "I got sick of the silly thing, I did not see what good it was," and this is precisely the other element in fatigue or tiredness, viz. the mental element, and it is just this element which plays such a large part in a nurse's life.

There are two aspects of it to be rather carefully separated: the first is that in which a nurse, very keenly interested in her work, absolutely forgets herself in the pure joy of doing things for her patients until sheer physical exhaustion or nervous breakdown com-

pels her rather suddenly and forcibly to give up work altogether for a time. The other aspect is that in which the nurse is keenly conscious all her time of the irksome and unpleasant nature of her duties; she is almost or quite consciously weighing, as it were, the pros and cons of a nurse's life compared with those of other occupations, and perhaps a little to the disadvantage of her own career. "What have these to do with exercise?" a nurse may well exclaim. Well, they have this to do with it—that the two types or two conditions want different plans for exercise and recreation.

Take the first type: Her body is a machine, which, practically unconsciously, is being driven at its highest pressure, until something gives way. Now send her off duty for some hours. What does she want? Recreation (creating anew), recuperation, not further conscious or unconscious exhaustion; she does not want a hard game of tennis, nor even a walk. For exercise a gentle stroll round a garden to sniff the flowers and get a breath of fresh air, and then probably the best thing is a novel and an easy chair, in the garden in summer, by the fire in winter, a light meal and a good sleep, and not till she has thus re-created herself does she require any exercise as ordinarily understood, and quite probably not even then. Such nurses—and to the honour and glory of nursing be it said there are hundreds such—require practically no exercise until the case is finished, and then they want a holiday varying from two to three

days to as many weeks to really regain a store of fresh bodily vigour.

Take the second type, to whom nursing is a simple business, something that has to be done, something liable to be felt as a wee bit wearisome and monotonous. Don't think I am blaming them; they are excellent nurses, perhaps in some ways even better than the first type; they do their work, and do it well, but they are conscious all the time of doing it, and the muscles and the mind get achy and tired: it is to such that a change of occupation comes as the best holiday. These are the nurses who want a good run, a mountain scramble, a game of tennis, or, failing these, a good long walk; for them no book, no comfortable lounges, but let them rest mind, aye, and even the muscles, by such active means with *change of scene* and invigorating exercise; to them it matters little what the exercise may be, from shopping to golf; they are not muscularly exhausted, they are mentally tired of their job for a time. (I have said, and will repeat, they are good nurses; let them not feel ashamed; their mental fatigue is only a part of human nature.)

To come to the mere physiology of active movement we need only repeat the very elements of physiology; it quickens respiration, and therefore oxygenates the blood better; it quickens circulation, which carries this oxygen more freely to tissues, and removes the waste products from the tissues; it increases perspiration, and so gets rid from the body

of more used-up material; it also increases the output through the kidney of waste matter; it strengthens muscles; it improves the tone of all organs, including the stomach, and so improves digestion generally speaking, but it is inadvisable to take very violent (for a nurse) exercise too near to a meal; don't play tennis within an hour after food, and don't take food within half an hour after ceasing to play.

Don't forget the mental element in fatigue.

DRAINAGE.

A NURSE is not, in her avocation, consulted as to how to build a house-drain, and I see no reason therefore why she should be burdened with details of dry or wet removal of sewage, nor the course, material, and shape of drains; these are the province of the architect and sanitary engineer. We may, however, state, *en passant* on such subjects, that when her nose persistently, or even casually, suggests to her that there is an offensive smell in a certain room in the house in which she is nursing, she might think of a gas-jet not turned off, of leaking gas or soil-pipes, or an old forgotten cesspool, or leaking drain, and mention her suspicions to the doctor or to the responsible head of the house. But here, in my opinion, her duty and responsibility end so far as smells and drains are concerned.

Her duties with regard to what I may term the drainage of the sick room include the disposal of:

(1) Motions, urine, and clothes soiled with the same, from the sick room.

(2) Refuse, bits and ends of food, from the same.

(3) Utensils used in the same.

(4) Dust collected in sweeping the sick room.

Removal of Excreta.

Motions and Urine.—In a case of ordinary, non-infectious illness she will probably content herself with emptying these straight away down the w.c., but she must also have either a sink there, with taps of water, preferably hot and cold, or must carry there a can or cans of water with which to cleanse the bed-pan or urine-bottle.

If, on the other hand, it is a case of infectious disease, typically typhoid fever, she is instructed, and rightly so, to let such stand in the bed-pan or bottle with a good strong dose of a disinfectant, probably crude carbolic acid, for at least half an hour before disposing of them as above.

Suppose she has been sent to an isolated country house or cottage, where there is no w.c.; such a possibility may be a rare one, and will probably get rarer, but it may occur. In such a case nurse had better ask the doctor for instructions, for she is face to face with just one of those problems which have puzzled very wise heads for a long time.

On the one hand, we know that typhoid and other disease germs cannot live long in contact with ordinary earth and its germs. If, however, we think we will not run any risk of this sort, but will kill the germs ourselves before committing them to kindly earth, our disinfectant may not kill them *all*, and so when the mixture is put on the ground our disinfectant may kill our friends the ground small fry

(microbes, worms, beetles, ants, etc.), and may let the typhoid survivors flourish by dilution of the antiseptic. No; let a nurse act on instructions in such a case, and leave the responsibility to wiser heads and broader shoulders than her own.

(1) *Clothes soiled with fæces and urine.*—These must be placed in large vessels; a bath is convenient, but if it be a bath that others want to use their wants must go unsatisfied until the case is at an end and the bath has been properly cleaned and newly painted. They must there be left to soak either in plain water or dilute disinfectant (for typhoid) for a good long time—several hours at least—before being roughly washed and sent to a laundry.

(2) *Refuse, bits of food.*—These should be carefully removed and placed in the proper receptacle, which may be (*a*) (and also best) a fire, or (*b*) a properly made dust-bin (*vide* below). On no account should they be sent back into the kitchen, particularly if the disease is even possibly infectious.

(3) *Utensils* used for the sick room are best washed separately, like soiled clothes, and if it is an infectious disease they *must* be so washed exactly like soiled linen above.

(4) *Dust collected in sweeping.*—Dust is composed of tiny fragments of anything and everything—wool, hair, cotton, linen, soil, mineral matter, ashes, etc.—but, above all, it has been conclusively proved that it invariably contains microscopic animal life, the germs of disease and other germs. Special kinds of

dust, separately considered, such as ashes from the grate, from a cigar, pipe, or cigarette, are, of course, originally aseptic, *i.e.* free from living germs, but before being swept up they get contaminated from numerous sources, so that the above wide generalisation may be taken to be always true in ordinary life.

Dust, then, may irritate the nose and air-passages (in the nose are special hairs to filter off dust-particles before the air enters the larynx; this is the importance of nose-breathing) either simply as foreign matter or by conveying germs to the portals of entrance to the body, and therefore must obviously be dealt with as carefully as circumstances will permit.

In sweeping the first care is to try and prevent the dust from rising up into the air; this can, to a certain extent, be prevented by scattering damp, spent tea-leaves or wet sawdust or similar material on the floor before sweeping; the particles of dust are rendered heavier by the damping, and not only so, but the tea-leaves being wet, the dust will cling to them and so be prevented from rising. A better plan, however, for sweeping is to use one of the several machines that are on the market for sucking up the dust into a closed receptacle, which is rolled to-and-fro over the area to be cleared up.

By one or other means, then, the dust is collected into a receptacle. What is now to be done with it? Beyond any question the right method of disposal is to burn it, but obviously, as with other scraps, there

are at least two conditions to be complied with: (1) There must be a fire handy, and (2) this fire must be burning sufficiently well, and be big enough to burn our dust or refuse without making a smell in the room. The stuff must be put well on to the back of the fireplace, from whence there is less chance of any fumes coming out into the room instead of going up the chimney.

Suppose, now, there is no fire, or not a big enough one; nurse must then ask to be provided with a dust receptacle which shall be of a reasonable size and provided with a lid which fits as closely as possible. The ideal article is made and sold as such; it is made of galvanised iron and has a tight-fitting lid, and is removed daily out of the nurse's jurisdiction; it is immaterial to her what becomes of it, though there is no doubt that its contents should be burnt and the thing itself thoroughly cleansed every day. If one wants to see a crying scandal, watch the nature and method of dealing with these things as they can be seen any day in the City or in high-class residential neighbourhoods in London, but that is not a nurse's fault.

INFECTIOUS DISEASES.

As a fitting chapter for the end of this little introduction to a nurse's hygiene we may say a few words on these troubles, which are the more important the more we recognise the very great number of diseases which are due to micro-organisms, and that, therefore, each patient is a potential centre from which the disease may spread, and as a nurse is the nearest object she is likely enough to be the first victim. In this connection it cannot be out of place to mention that fleas, bugs, body-lice, many kinds of mosquitoes and other parasites have been proved to be capable of carrying disease from patient to nurse.

This has another point of view, as follows: Suppose the patient is suffering from the effects of an invasion of microbes—"blood poisons" or "toxæmia" as they are scientifically termed—but is not now perhaps an active centre of distribution, a nurse coming into the house may subject herself to the same source for the microbes that her patient had already subjected himself to, and so may become infected. This view renders it just possible and conceivable that we might demand from a nurse a greater knowledge of hygiene

than I personally think necessary, but my view is that this aspect of the case will have been, or ought to have been, already dealt with by the doctor or by the Medical Officer of Health. We must let this pass with the observation that this idea of matters should make a nurse doubly careful of proper hygienic measures in her own person.

Now, if a person is affected with an infectious disease there will be some channels or means by which the microbes can escape from him, and each channel indicates the special direction in which a nurse should be extra careful, though she should never neglect any. Let us consider these in turn.

(1) *By the breath or mouth*, with sputum and saliva : This is particularly the case in typhus (of which I have never seen a case—it is very rare), pneumonia, phthisis, whooping-cough, diphtheria, abscess in the tonsils, abscess and gangrene of lungs, perhaps, too, measles and scarlet fever, and possibly hydrophobia.

In these cases, and doubtless some others that occur, it is of special importance that the nurse should not bring her face, nose, or mouth, too near the patient's mouth or nose ; she must be particularly careful of all sputum and other discharges from mouth or nose, burning them at once if possible, and then must be particularly careful not to rub her own eye, nose or mouth with her hand that has been wiping the patient's mouth or nose until she has thoroughly disinfected the hands.

(2) *By the skin (sweat and scales)*.—It is very doubt-

ful how far this is directly a means of escape of infection, but there is some evidence to suggest it in measles and scarlet fever, and certainly in erysipelas, in ringworm and other parasitic skin diseases, but there can be no doubt but that discharges of all sorts may *reach the skin from anywhere*, and from there be conveyed to a nurse's hands in turning a patient over in bed, etc.

We get, then, the general rule that it is impossible for a nurse to be too careful about cleaning her hands after touching her patient, no matter how often she has to wash.

(3) *By the motions and urine.*—This is particularly true of typhoid, of vaginal discharges, of puerperal fever cases, of troubles with infection of the genito-urinary passages.

The same remarks will apply as before to nurse's care.

(4) *By discharges of pus* from foul wounds, abscesses and the like. Here, again, it is practically impossible but that a nurse shall get her hands contaminated often enough, and we can only again emphasise the necessity for very frequent disinfection of the hands.

For the meaning of the words "disinfectant," "antiseptic," and "deodorant," *vide* "Definitions,' p. 163 *et seq.*

We may here suggest a practical means of disinfection of a nurse's hands.

One of the most important points is "never let

any infectious matter dry on the skin ; never let it stay long enough on the skin to do so." (In my own work as pathologist, constantly exposed as my hands and arms are to every kind of pathogenic organism, I believe the above to be the only rule of safety, much better than the wearing of gloves, india-rubber or other kinds, for I am constantly rinsing my hands in plain warm water, which is just as septic as the body, and I can always trace any infection to delay in rinsing, and it is remarkable how rarely I have been infected, though my hands are by no means free from cuts and scratches.) This, in its turn, means a handy basin with a jug of water never allowed to be empty and a bottle of lysol or sanitas, or 1 in 20 carbolic, so that a tablespoonful or so of one of these can be emptied into the basin of water at once ; the solemn and prolonged ritual of the operating surgeon is not necessary for a nurse provided only she will wash very frequently.

A word or two on cuts and scratches. These should always be attended to, and the best form of attention is perhaps as follows : Immediately on their occurrence they should be bathed in a little warm or cold water to which a little weak antiseptic has been added until hæmorrhage has practically ceased. A few drops of tinct. of iodine may then be poured on. A small piece of boracic lint or other dry surgical dressing should then be applied with moderate firmness and tied on with a bit of bandage or linen—in fact, a nurse should treat her own cuts as she is

taught to treat those of others. Another point I wish to make is this, that when hands on which cuts and scratches are, have to be washed, take care that the small wound is well cleansed and a fresh dressing applied. Don't keep the dressing on while washing, in the hope that no harm may ensue.

COOKING.

Hygiene or Public Health in its wider aspects is very much concerned with the amount and nature of the daily quantity of food required to keep human beings in health (a fair average works out at about $3\frac{1}{2}$ oz. protein, $2\frac{1}{2}$ oz. fats, 14 oz. carbohydrates). Into this matter it is no part of a nurse's duties to enter, but it may very easily be both her pleasure and her duty to consider the preparation of this food so as to present it to her patient in the most digestible, palatable, and appetising form. It may make this elementary little book more useful if I add a chapter on the "why" of many things she is taught to do in the kitchen without any reason beyond the "I say so" of her teacher.

As food appears in the kitchen the classes of food-stuffs in it take the following shapes approximately:

Proteins = butcher's meat, poultry, fish, savoury entrées, etc.

Fats = butter, dripping, lard, bacon fat, etc.

Carbohydrates = all cereals, either as flour or more or less crushed or whole corn, also sugars.

Fruit and vegetables.

All of these can be, and are, under circumstances of choice or pressure, eaten raw, but far more usually heat is applied to them for one purpose or another according to the intentions of the cook ; in fact, just as we have the above classes of food-stuffs so we have the following classes of cooking :

(1) The application of mere heat = baking, roasting, grilling, frying, etc.

(2) The application of boiling water or steam.

(3) The introduction of flavouring agents.

I must now lay down a few general propositions regarding the chemistry and physics of food-stuffs and common cookery operations and then apply them to a few illustrative dishes.

(*a*) All food-stuffs (like all clothing material) are essentially bad conductors of heat, the result of which is that heat penetrates them comparatively slowly, *e.g.* it takes 3½ min. to boil an egg moderately lightly, though 3½ sec. in boiling water would blister a finger badly.

(*b*) Heat causes a coagulation of the albuminoid or protein constituents of food-stuffs; this coagulation begins to take place somewhere about 170° F., and as the heat continues or gets greater the coagulation gets firmer and forms a sort of coat to the food more impervious to heat from without and also more impervious to moisture from within. This coat will crack under the influence of heat.

(*c*) All food-stuffs contain water (fruit and vegetables most, meat less, and flours and starches less, but still

some) not only between the cells, but also actually in the cells of which they are composed; moreover, water is actually added to the drier food-stuffs in culinary operations.

(*d*) Water boils at 212° F. or, in other words, becomes compulsorily converted into aqueous vapour; if the pressure be increased, as in a closed stew-pot or Papin's digester, water can be heated above 212° F. and then possesses higher solvent power and the aqueous vapour more penetrative power.

(*e*) The chief nutrient element in all cereals is arch. Starch is contained in granules with a coat difficult of penetration by the alimentary juices, consequently these starch granules require to be burst by the heat of cooking somehow; compare the taste of a badly-cooked batter pudding with that of one that is properly cooked. Heat converts some small proportion of the starch into a form of sugar.

This article is in no sense meant to be a cookery recipe book, but we may apply the above proposition to a few simple cookery procedures.

Beef-tea, for instance. The best way to make this is based on the fact that with the aid of a little vinegar, ʒj to the pint, and a pinch of salt, lean beef can be almost entirely dissolved in cold water, by letting the beef stand 4 or 5 hours in water with the salt and vinegar added, the cold solution of beef then only requires to be slowly heated to a temperature satisfactory to the patient's taste.

In boiling a piece of beef, if we want the goodness

of the meat kept in, we plunge it into a fairly large quantity of boiling water in order to coagulate the outside as quickly as possible; if, *per contra*, we want to have the soup rather than the meat we put it into cold water first and gradually warm it up, thereby dissolving as much as we can out of the beef.

Stewing generally means *prolonged* action of heat at about 170° F., thus allowing time for the fibres of the meat to be ruptured by the water in them.

The gelatine of bones is extracted by superheated water in a Papin's digester (*vide* p. 70), a useful hint for making soup stock.

The making of toast is a simple little operation often sadly bungled by haste or ignorance. The thinner the toast and the slower the fire the more is the bread dried right through, the brighter and brisker the fire the more rapidly can we impart a nice brown coat to the bread by slight scorching.

Gravy in its natural form should consist of the natural juice of the meat forced out of it by heat.

Grilling is chemically different from roasting in that it consists in the short application of a great heat to the outside of a small piece of meat, roasting being the long application of somewhat less heat: a grilled chop has all the gravy inside, a roasted chop has the gravy in the plate.

Heat cooks fruit and vegetables partly by solution or semisolution of their fibres, partly by the bursting of their cellular structure by boiling of the water in them. Fruit is stewed mainly in its own water, vege-

tables are boiled in a fairly large quantity of added water. A floury potato is one in which most of the starch granules are burst and dry, a waxy one is one in which the starch granules have mostly refused to burst or to dry.

GENERAL DEFINITIONS AND GLOSSARY OF TECHNICAL WORDS.

Atmosphere.—In strict language this should only be applied to the whole body of air (with all that the air contains) which surrounds the earth or a star (of which the earth, the sun, the moon, etc., are merely examples), and properly we should only apply the adjectives terrestrial (the atmosphere surrounding the earth), solar (that of the sun), lunar (that of the moon), stellar (that of a star), etc., to it, but by common consent and for convenience we also speak of the atmosphere of a room or hall, etc., when we should more correctly speak of the "air" of these smaller spaces. To states of the open atmosphere of the earth we may apply such adjectives as hazy, foggy, clear, bright, etc., to states of the air in lesser spaces we apply such adjectives as stuffy, fresh, etc., but with fair appropriateness the terms may be interchanged at will provided we remember the original definitions. A further chemical use of the word is for the gas in any given *closed* vessel to which a liquid or solid can be exposed.

Capillary attraction.—By this term is meant the fact that when water or other liquid is placed at the

mouth of an exceedingly fine tube (the word capillary itself is derived from our blood capillaries—the finest of our blood vessels) or the tube brought into contact with the surface of the water the water enters the tube and fills it for a considerable distance. The explanation is very abstruse and difficult and need not be entered upon, but the fact is of extreme importance, as it is by capillary attraction very largely that our clothes absorb moisture and a lamp continues to burn by sucking up oil or spirit out of the reservoir.

Climate may be defined as the average weather prevailing over a fairly large area. It is not usual to speak of the climate of a small locality, unless for geographical reasons that locality enjoys a different average of weather to that of the country of which the locality forms a small part.

Cubic capacity.—The contents of a solid, and in a bedroom is obtained by multiplying height by length by breadth, but each must be in feet or yards or metres, etc., not one in one dimension and the others in other dimensions.

Deodorant.—A body which is capable of overpowering a noxious smell by its own stronger smell. It must be noticed that whereas a disinfectant may be, and very likely is, a deodorant as well, a simple deodorant is practically never a disinfectant.

The distinction in general is of no importance, but when applied to a given individual substance it is of the last degree of importance to determine

whether it merely disguises a bad smell or whether it effectually destroys or puts an end to the cause of the smell, viz. the decomposition.

Disinfectant.—A body which is capable of destroying micro-organisms, and also very frequently of decomposing bad gases, *i. e.* offensive or noxious gases. Perchloride of mercury, carbolic acid, and iodine are perhaps the best illustrations.

Distillation.—The term is given to the result of applying heat to liquids and solids whereby they are more or less rapidly converted into gases, which pass over (*i.e.* distil) from one vessel into another, or into the air, these (unless permanent gases) again condense back into liquids or solids—the process described on p. 51 is the distillation of solids; it must be conducted in the (comparative) absence of oxygen, or the intense heat will cause the gases to burn.

Elastic.—The property of yielding to a pull or push, *but also* of returning to the original shape, thus india-rubber or glass is elastic, dough is not.

Fumes is merely a derogatory term for gases which to any individual happen to be unpleasant, or which are in general noxious; thus we speak of the fumes of acids where these bodies assume a gaseous form (*vide* p. 23 or 51), or the obnoxious fumes of a stove, etc. Aroma is the complementary term for the same thing.

Menstruum.—A scientific term for the liquid in which something is being dissolved or suspended—

very much like the use of the term atmosphere in chemistry, only that menstruum is usually reserved for liquid.

Nitrogenous merely means containing nitrogen; a term usually reserved for food-stuffs, and is almost equivalent in this connection to protein—at least, all proteins are nitrogenous.

Nomenclature.—A system of naming objects.

Protein.—A term for nitrogenous food-stuffs.

Saturation and Saturated.—As full as it will hold, applied to gases and liquids or spongy solids; when anything is dissolved in the gas or liquid and the menstruum has dissolved as much as it can.

Specific gravity.—By this term we mean the weight of a given volume or bulk of substance compared with the weight of the same volume or same bulk of a given standard substance. For gases hydrogen is commonly taken as the standard; for liquids and solids water is usually used. For instance, in testing urine, if the specific gravity is found to be 1025, this means that a given volume of urine is heavier than the same volume of water in the proportion of 1025 to 1000.

Specific heat.—Scientifically means the amount of heat required to raise a unit of mass of any substance 1° C. in temperature. My reason for inserting it is its importance in connection with warming the sweat at the expense of the body heat. Water has the highest specific heat of all known substances and hence can absorb or make latent, *i. e.* not appreciable,

a very large quantity of heat, hence the coldness of wet clothes.

Suspension and suspended matter.—These are the opposites of precipitation and precipitated matter. The terms are constantly cropping up in hygiene, and their meanings should be grasped. The former two refer to the fact that gases and liquids are able to sustain or suspend in their substance certain other matter; this latter is commonly in very fine particles which are approximately of the same specific gravity (*vide* above) as the gas or liquid containing them. The more nearly the specific gravity of the suspended matter approaches that of the gas or liquid the longer will the fine particles take to settle to the bottom (precipitate or precipitated matter if their specific gravity be the greater), or to float to the top (if their specific gravity be the less); the rising of cream to the surface of milk is an illustration. Sand in water and particles of dust in the air are illustrations of small suspended bodies. An illustration of a larger floating body is a gas balloon in the air, or a piece of wood, or a human body, let us say, in sea-water. The essential point of the term is that the floating or suspended particles shall not dissolve or chemically combine with the gas or liquid in which they find themselves.

Translucent.—Allowing light to pass through more or less perfectly.

Weather is the condition of the atmosphere either at a given time or place, and the general run of the

weather constitutes a climate. The elements that form weather and climate are rainfall, sunshine, clouds, temperature, and barometrical pressure, that last, perhaps, too technical to bother about, though it has an all-important bearing on the other points (*vide* "Air," where it is somewhat explained).

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ADLARD AND SON, IMPR., LONDON AND DORKING.